[Established 1832]

THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE (Inc.)

140 NASSAU STREET, NEW YORK

J. S. BONSALL, Vice-President and General Manager

F. H. THOMPSON, Eastern Advertising Manager.

E. A. AVERILL, Editor.

APRIL, 1910

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THE DRAFT GEAR SITUATION.

By Kenton Adams.

[EDITOR'S NOTE.—AT OUR REQUEST THE AUTHOR OF THIS ARTICLE HAS GIVEN HIS IDEAS ON THE DRAFT GEAR SITUATION. WHILE WE ARE NOT PREPARED TO ENTIRELY AGREE WITH ALL OF THE OPINIONS EXPRESSED, OR TO BELIEVE THAT CONDITIONS ARE ACTUALLY AS SERIOUS AS HE INDICATES, WE DO BELIEVE THAT A FRANK DISCUSSION OF AFFAIRS AS THEY EXIST WILL DO NO HARM. THEREFORE WE WILL BE VERY GLAD TO RECEIVE OTHER EXPRESSIONS OF OPINION FROM BOTH RAILWAY MEN AND MANUFACTURERS WHO ARE IN A POSITION TO SPEAK FROM PERSONAL EXPERIENCE, AND WILL PUBLISH AS MANY OF SUCH LETTERS AS POSSIBLE IN SUCCEEDING ISSUES. IF YOU KNOW ANYTHING ABOUT DRAFT GEARS LET US HEAR FROM YOU.]

You ask me to give my ideas on the draft gear situation. While possibly I am not as well fitted to speak on this subject as some others, still I have given it considerable study and have had a far amount of experience with draft gears. Taking everything into consideration the situation appears to me to be serious, in some cases even very serious. As I look back I do not remember a time when there has not been more or less trouble with draft gears. Much progress has, of course, been made in the design and construction, attachment and location of draft gears during the past ten years, but requirements seem to have increased as fast, if not faster, than the improvements, so much so that it seems as if now, in spite of all the money and talent that have been given to a study of the subject, the elaborate tests that have been made, and all the investigations and reports of able committees, the situation is in nearly as bad shape as it ever has been.

This may seem to some to be pessimistic; if it does, let them take a trip through a large car repair yard and see if they can find anythng about draft gears to make them optimistic. Let them see how many bent and broken striking plates and crushed end sills are to be found that will indicate very forcibly how badly the capacity of the gears have been exceeded in service. Let them look at the broken knuckles, the sheared rivets in the sills and coupler shanks, to say nothing of the broken gears themselves. I do not believe that such an investigation will impress any one as reflecting a satisfactory draft gear situation, or indicate that the draft gear problem has been solved. You may say, "but the draft gears are misused," certainly they are, but where is the man to be found that can stop this misuse and keep his yards reasonably cleared. Misuse is not an excuse. The gears must be made to stand the service as it exists, and all the blame cannot be laid to the yard crews, either.

Consider further the expense resulting from this one trouble: the claims resulting from an occasional wreck; the delay on the road due to break-in-twos; the cars out of service; the transferring of loads, as well as the repairs themselves. These represent a very respectable sum, even in comparison with such things as the coal bill and the cost of operating trains. It is these things that lead me to say that the situation is serious.

Has everyhing been done that can be done? By no means. On this point I am optimistic. The problem will be solved eventually, no doubt; just how it will be done I am unable to say. There are new designs of draft gears being brought out all the time, some of which seem to have excellent possibilities. Every practical road test made shows up some weak features and some strong ones in the different designs. There will be testing machines built that will reproduce actual service accurately enough to give data which will hasten the determination of the good features and the discarding of the weak ones in the designs tested, so that by a process of elimination no doubt the proper combination will be eventually secured. Possibly several arrangements of different principles will prove themselves capable.

From present appearances it looks as if a combination of spring and friction surfaces would be the basis of the final solution. In fact it seems to be pretty generally admitted that one of the principle functions of the draft gear under modern conditions is to absorb and dissipate the energy of the pull or push that is greater than, say, 50,000 lbs. Friction seems to be the most practical way of doing this, although there are, of course, other means of dissipating energy that may finally be adapted to this use. Below 50,000 lbs. springs are in every way satisfactory. They cushion the constantly recurring shocks that would soon rack a car all to pieces. They yield quickly and with an increasing resistance which permits the locomotive to start a long train with ease, and if it was not for the fact that a spring is unable to absorb and dissipate energy the problem would be solved without any further investigations. But when it comes to a point where blows of several hundred thousand pounds are delivered to a gear, springs alone are out of their class, not because they are unable to stand it, but because the car and coupler are unable to stand the recoil.

Therefore I believe that some type of spring will be used for what can be called ordinary use and that this will be supplemented by an arrangement which will absorb and dissipate blows that are out of the ordinary. This seems simple enough, and there are a number of gears at present in more or less extensive use that are designed to do exactly this. The only difficulty is that they are not doing it successfully, at least in all cases. Some of them were entirely successful at the time they were first designed, but they have been unable to stand up to the continually increasing requirements.

I don't wish to be understood as saying that there are no successful draft gears now in service, but simply to state that, in my humble opinion, there are no draft gears now in extensive use that are successful under all conditions of service, *i. e.*, I have been unable to find a gear that I am willing to point to and state "this is perfection; we need look no further."

INCREASING THE EFFICIENCY OF WORKMEN.

To summarize: If you keep an exact record of what each worker does, surround the men with conditions under which they can work at high efficiency, and compensate the efficient one liberally, no man will spend his spare time in trying to find out how to raise the wages of the other fellow. Workmen, as a rule, will do more work if their earnings are increased by so doing, and you will find great difficulty in getting the efficient ones into labor unions if they are not benefitted by joining.

The point that seems very clear is that the employer is quite as much responsible for the labor unions as the men are themselves, and that he can never expect to adjust his difficulties with the employees until he furnishes them with a means of accomplishing their ends (namely, bettering their condition and getting more money) which will appeal to them as being better than the means that they are now using; for, as was said before, so long as he conforms to the laws of the State, the workman has a right to govern his actions in the manner that will best subserve his interests. As we cannot make him do anything else, we must convince him first that what we offer is better than what he already has. When he is convinced, the problem is solved.—*H. L. Gantt in The Engineering Magazine.*

FOR THE SHOP SUPERINTENDENT AND FOREMAN

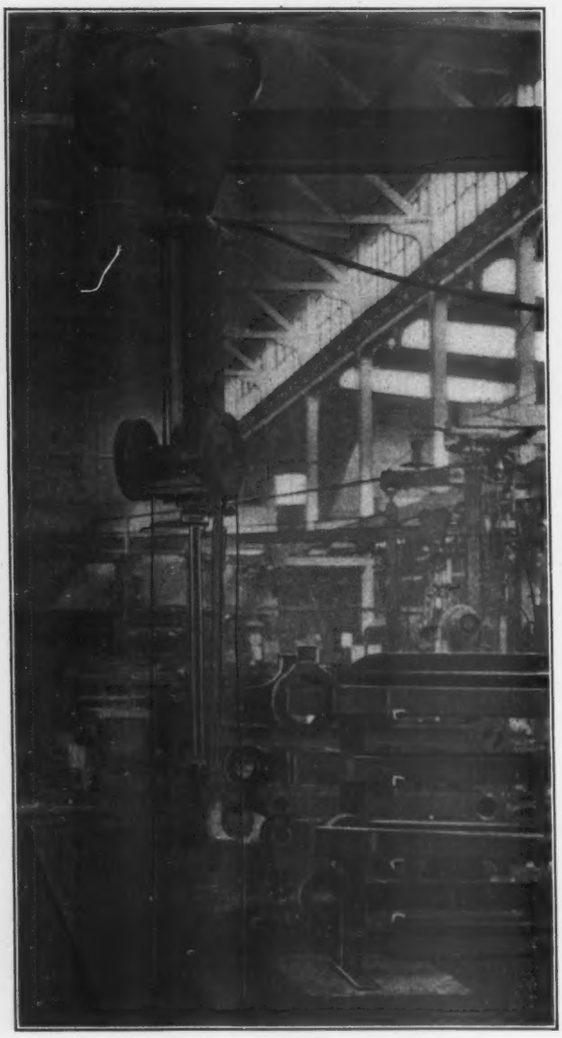
[EDITOR'S NOTE.—THE FOLLOWING JIGS AND HOME-MADE DEVICES HAVE BEEN COLLECTED VERY LARGELY FROM THE READVILLE LOCOMOTIVE SHOP OF THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD AND THE WEST SPRINGFIELD SHOP OF THE BOSTON & ALBANY RAILROAD. OTHER SHOPS CAN MAKE NEARLY, IF NOT QUITE AS GOOD, A SHOWING, AND WE WILL BE GLAD TO OBTAIN AS MUCH MATERIAL OF THIS KIND THAT HAS NOT PREVIOUSLY BEEN PUBLISHED AS POSSIBLE. WE ARE GLAD TO PAY LIBERALLY FOR ARTICLES FURNISHED US EXCLUSIVELY THAT ARE ACCEPTED FOR PUBLICATION.]

PNEUMATIC HOIST WITH INCREASED LIFT.

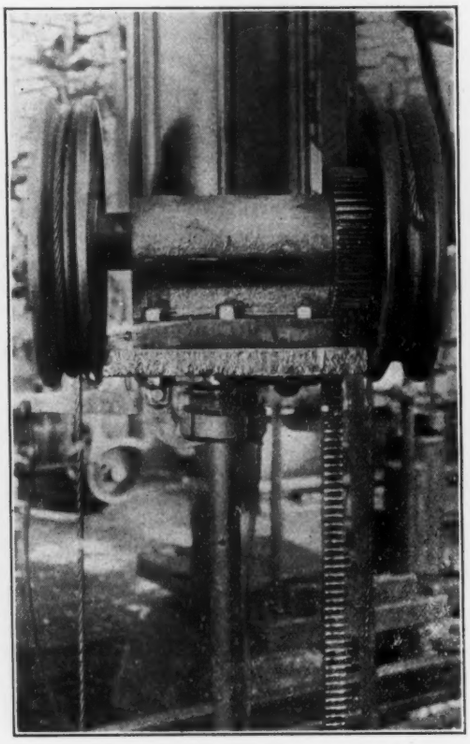
The great disadvantage of an air hoist consisting simply of a supported cylinder is that in lifting heavy weights it raises them rapidly and with a jerk, it being practically impossible to gauge the height of lift with any accuracy and also when lowering, the rods or other parts that are being handled are practically given a free drop. In spite of this, however, the air cylinder hoist is very commonly used because of its cheapness and simple arrangement.

To avoid these difficulties an arrangement has been applied to the air cylinder used in the rod gang at the West Springfield shops which not only permits it to give a positive lift that can be accurately adjusted, but also increases the height of the lift as compared to the stroke of the cylinder.

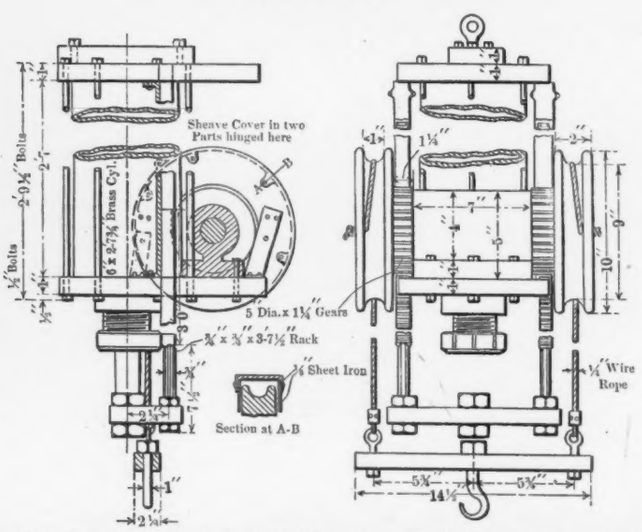
As will be seen in the illustrations, this arrangement consists



AN AIR HOIST WITH LONG LIFT AND POSITIVE ACTION. THE AIR PISTON OPERATES A RACK WHICH MESHES WITH GEARS ON THE SHAFT ABOVE TO WHICH THE CABLE PULLEYS ARE KEYED. THE EXAMPLE SHOWN HAS BUT ONE RACK. A LATER DESIGN EMPLOYS A DOUBLE RACK. IT IS USED IN THE ROD GANG OF THE WEST SPRINGFIELD SHOPS.



A CLOSE VIEW OF THE AIR HOIST SHOWING THE RACK AND GEAR.



DETAIL SHOWING CONSTRUCTION OF PNEUMATIC HOIST WITH INCREASED LIFT.

simply of a cross bar at the end of the piston rod to which are connected two racks that are guided in a frame at the bottom of the cylinder and mesh with the gears on a shaft, to which two sheaves are keyed, the shaft being carried in bearings that are secured to an extension of the plate forming the lower cylinder head. The two sheaves carry cables which are connected at the lower end to the cross bar with a hook in its center.

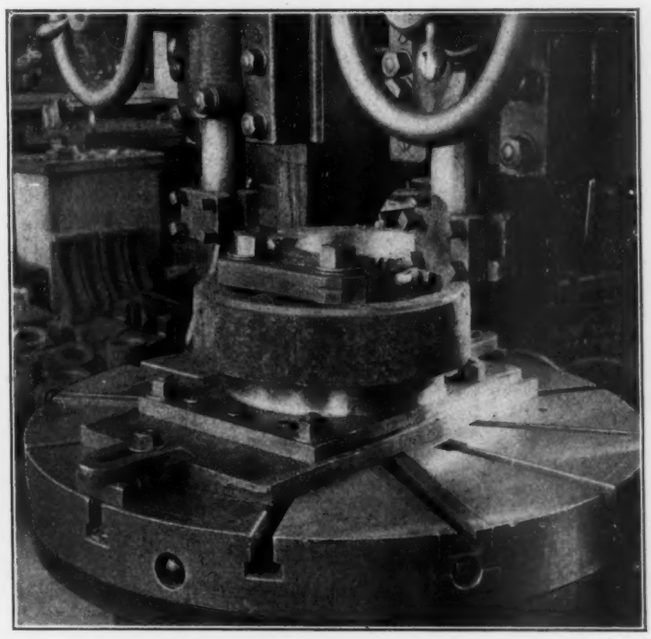
It is evident that the size of the sheaves can be adjusted so as to give any lift desired within the lifting capacity of the cylinder, the greater the lift the smaller the capacity and also that the racks and gears form a friction brake which largely eliminates the rebound when raising or lowering.

BORING AND TURNING ECCENTRICS.

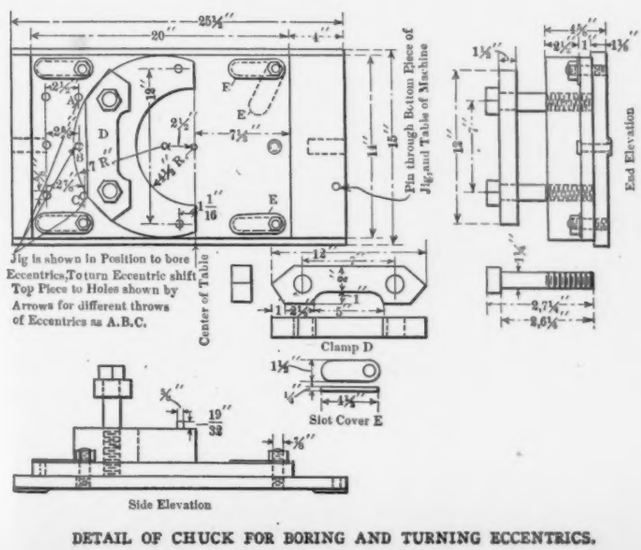
A jig which permits the accurate boring and turning of an eccentric on a boring mill without re-setting, is shown in the accomanying illustrations. It consists of a plate clamped and pinned to the table of a boring mill, upon which is seated a second plate having a crescent shaped raised part for holding the eccentric. This upper plate fits between raised bosses on the lower and the bolts connecting them together pass through slotted openings in it.

The eccentric is clamped on top of the raised section of the upper plate and either bored or turned as desired. That operation being completed, the bolts are loosened and a 5/8 in. pin which passes through both plates, is raised, permitting the upper plate to slide a distance equal to the throw of the eccentric, when the pin is again inserted, there being holes drilled to suit the different sizes. It can then be completed without further adjustment.

It is claimed at the Readville shops, where this device was gotten up, that it gives a saving of 50 per cent. over the old method of doing work.



VIEW SHOWING THE ECCENTRIC BORING AND TURNING JIG ON A BULLARD BORING MILL. AFTER THE ECCENTRIC IS BORED THE UPPER PLATE IS SLIPPED ALONG THE BASE A DISTANCE EQUAL TO THE THROW AND THE TURNING CAN START WITHOUT FURTHER ADJUSTMENT.

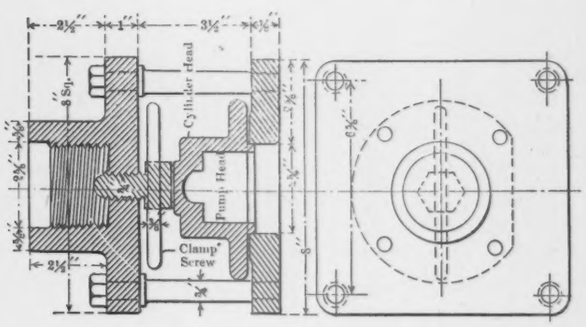

Jig is shown in Position to bore Eccentrics, To turn Eccentric shift Top Piece to Holes shown by Arrows for different throws of Eccentrics as A.B.C.
Center of Table
Pin through Bottom Piece of Jig, and Table of Machine
End Elevation
Clamp D
Slot Cover E
Side Elevation

DETAIL OF CHUCK FOR BORING AND TURNING ECCENTRICS.

BORING LEFT MAIN VALVE CYLINDER HEAD, WESTINGHOUSE AIR PUMP.

The difficulty of holding the left main valve cylinder head for boring has developed a chuck, which is fitted to the spindle of a lathe, that performs this service most satisfactorily at the Readville shops.

This chuck consists of a face plate secured to the lathe spindle, from which is supported by four bolts a plate having an opening of the proper diameter to take the lip of the cylinder head. In the center of the face plate is a screw clamp which sets against the top of the head and holds it securely in position. A lug that fits against the flat side prevents it from turning.



JIG FOR BORING LEFT MAIN VALVE CYLINDER HEAD—WESTINGHOUSE AIR PUMP.

USING OLD BOILER LAGGING.

Most railroads make their own lagging for locomotives that have gone through the shop. This in some cases consists of a mixture of lime and asbestos softened with water. It has been the usual custom to throw away the lagging removed from the boiler when it comes in and to supply new lagging complete as it goes out.

At the Collinwood shops it has been the practice for three or four years to grind up the lagging taken from a locomotive and by mixing with a small amount of new material it is suitable for application to engines going out. This is done by collecting the old lagging at one point in the shop where a rattler, the surface of which consists of small slats with narrow spaces between them, is installed in a large box. The old lagging is put into the rattler and several pieces of bar iron with round corners are thrown in and the machine is started. As the lagging becomes pulverized it drops through the spaces between the slats and is then shoveled out, there being a door at the bottom of the box for this purpose, and taken to the vat where it is mixed with water and is then ready for use.

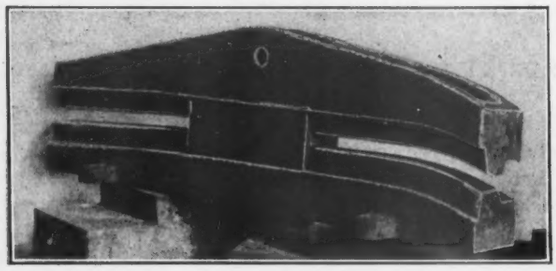
Analysis of costs, under the old and new methods, show that where it previously cost $23 for material and labor to lag a large

locomotive, the cost at the present time is less than $8, leaving a saving of over $15 per locomotive. It is found that about 70 per cent. of the lagging can be saved and used over in this manner, which is not only a matter of economy in the saving of the material, but also prevents it littering up the shop and eliminates the trouble of carrying it to the scrap bins and scrap cars.

PNEUMATIC FORGING MACHINE.

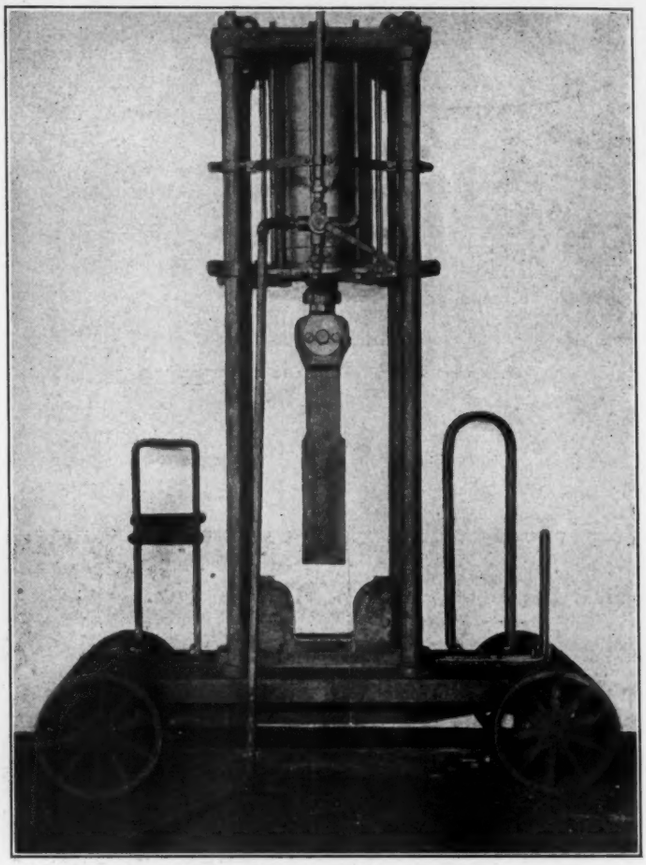
Forming guard rails by hand is a very tedious, as well as expensive, process, and in blacksmith shops which are crowded with work, an order for 50 or more guard rails is not received with pleasure.

This difficulty at the West Springfield shops has been overcome

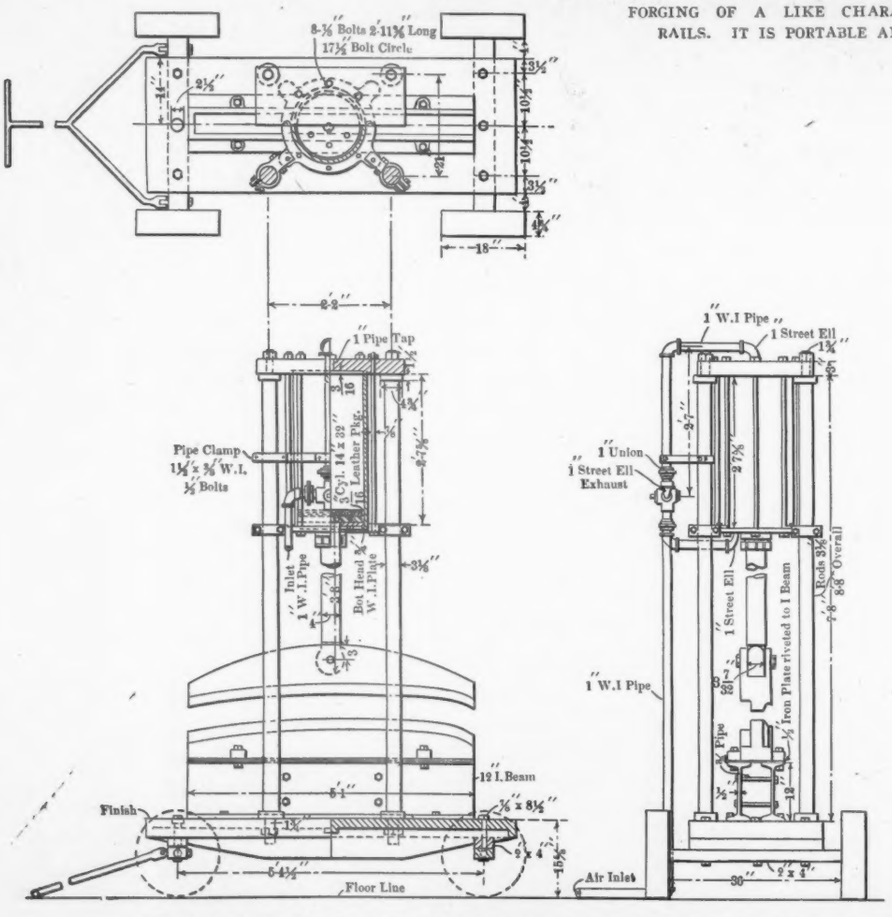


DIES FOR FORMING GUARD RAILS UNDER A PNEUMATIC FORGING MACHINE. BOTH BENDS IN ONE END OF THE RAIL ARE MADE IN ONE OPERATION.

by the use of a pneumatic forging machine, which was designed and built at the shops. It consists of a heavy cast iron bed plate, mounted on a truck, supporting four 3¼ in. hollow columns, which in turn support a 14 inch air cylinder having a stroke of about 30 in. Upon the piston rod and on the bed plate



PNEUMATIC FORGING MACHINE EQUIPPED WITH DIES FOR FORGING DRAFT GEAR YOKES. THIS MACHINE ALSO DOES OTHER HEAVY FORGING OF A LIKE CHARACTER, INCLUDING GUARD RAILS. IT IS PORTABLE AND OF LARGE CAPACITY.



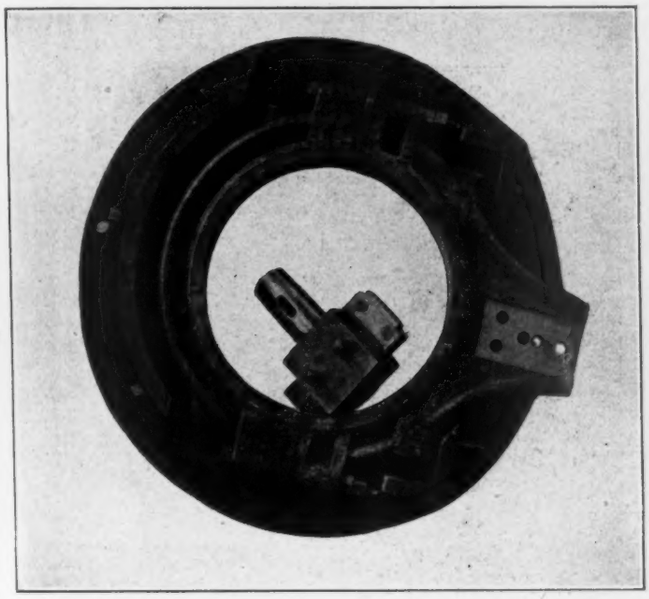
VERTICAL PNEUMATIC FORGING MACHINE FITTED WITH FORMERS FOR MAKING GUARD RAILS.

are mounted the dies. Not only are guard rails formed in this manner with great ease and rapidity, but heavy coupler yokes and other similar forgings are also being made. The machine can be moved anywhere around the shop, as needed, and has proven to be a most profitable device.

There is air admission both at the top and bottom of the cylinder, with a four-way valve on the air line so arranged that when air is being admitted to either side of the piston it is being exhausted from the opposite side. The construction and arrangement of the machine are clearly evident from the illustration.

BORING MILL CHUCK FOR ECCENTRIC STRAPS.

Because of their irregular shape the chucking of an eccentric strap on a boring mill table is usually a matter of some difficulty and requires considerable time. When there are a dozen



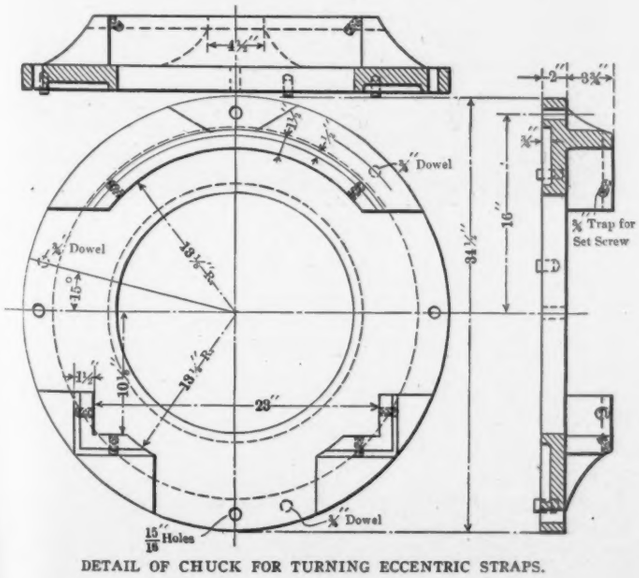
ECCENTRIC STRAP BORING JIG AND FORMING TOOL. THIS JIG ON A BORING MILL AFTER BEING ADJUSTED TO ONE SIZE OF STRAP REQUIRES ONLY THE SLACKING OFF AND TIGHTENING OF TWO SET SCREWS TO PROPERLY SET OTHERS OF THE SAME SIZE.

or so to be finished, each of them requires nearly the same effort and the total cost of time during which the machine is not in operation is all out of proportion to the value of the work done.

A special chuck or jig which largely obviates this difficulty and has made it possible to reduce the piece work price on this job by 56 per cent. has been designed and is in use at the West Springfield shops. The illustration shows its form and the method of securing the strap in it. The base is turned circular and the chuck is first approximately centered on the bed of a boring mill. A strap is then put in and accurately centered and secured by the set screws. When it is to be removed the set screws on one side only are released and the next strap can be put in and tightened without further calipering.

On new work a roughing cut is first taken and then the finishing tool shown in the center is run in and cleans up the cut, bringing it to the required diameter. On repair work the finishing tool only is usually required.

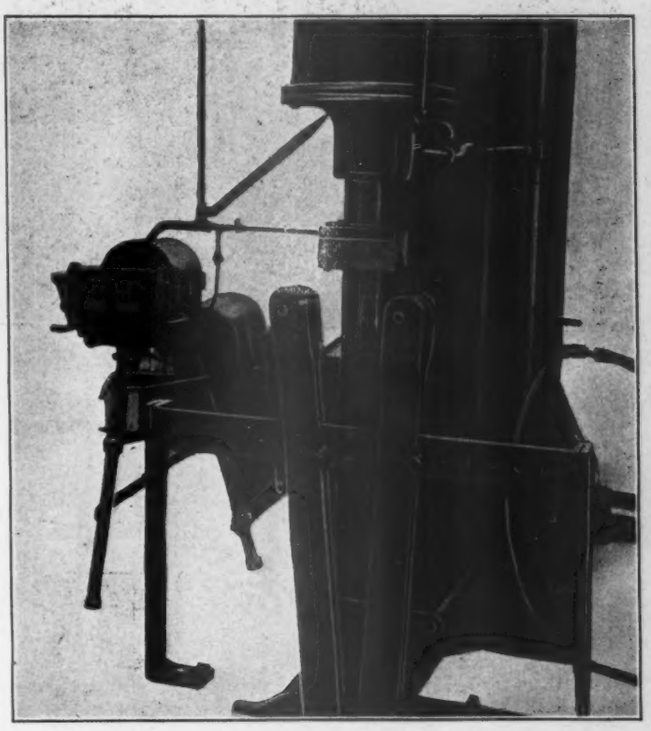
Different sized chucks are provided for the various classes of straps.



DETAIL OF CHUCK FOR TURNING ECCENTRIC STRAPS.

SIMPLE PIPE BENDER.

On one of the columns between the machine and erecting shop at Readville is secured a 14 inch air brake cylinder on the piston of which is a block secured to a simple cross head sliding on a guide secured to the post just back of it. Below this cylinder are two arms pivoted at the floor, the top of which are forked



VIEW SHOWING A HOME MADE PIPE BENDING MACHINE. THE ARMS HINGED BELOW CAN BE SWUNG APART SO AS TO GET PRACTICALLY ANY RADIUS BEND REQUIRED. THE MACHINE AT THE LEFT IS AN AIR OPERATED PIPE THREADER, WHICH IS LUBRICATED BY A HOME MADE SIPHON OPERATED BY AIR.

and carry rollers. These arms are held in any desired position by pins in a frame that passes through them.

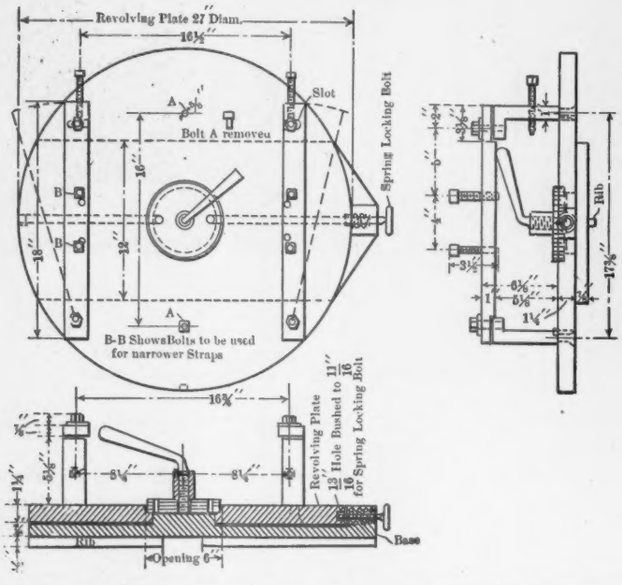
In bending a pipe any desired radius can be obtained by swinging the arms apart or together. They are quickly adjusted and the cylinder is of sufficient size to bend all pipes required on a locomotive. A gauge is mounted on top of the cylinder and a locomotive equalizing reservoir is fitted in the air line leading to it.

Alongside of this pipe bender is a pipe threading machine, mounted on a simple tripod of pipe and fittings, which is driven through gearing from an air motor. Underneath the threader is a shelf that carries a specially shaped pan, into which the lubricant drains after passing through a sieve. An air siphon arrangement draws it out of the pan and circulates it over the cutters again.

DRILLING AND TAPPING ECCENTRIC STRAPS.

On the eccentric straps used on the New York, New Haven & Hartford Railroad there are 18 operations of drilling and tapping, not including the holes for the eccentric rod. This work

ECCENTRIC STRAP DRILLING JIG. THE PLATE HOLDING THE STRAP CAN BE REVOLVED SO THAT ALL OF THE DRILLING AND TAPPING, EXCEPT FOR THE ECCENTRIC ROD, CAN BE DONE WITHOUT REMOVING THE STRAP FROM THE JIG.



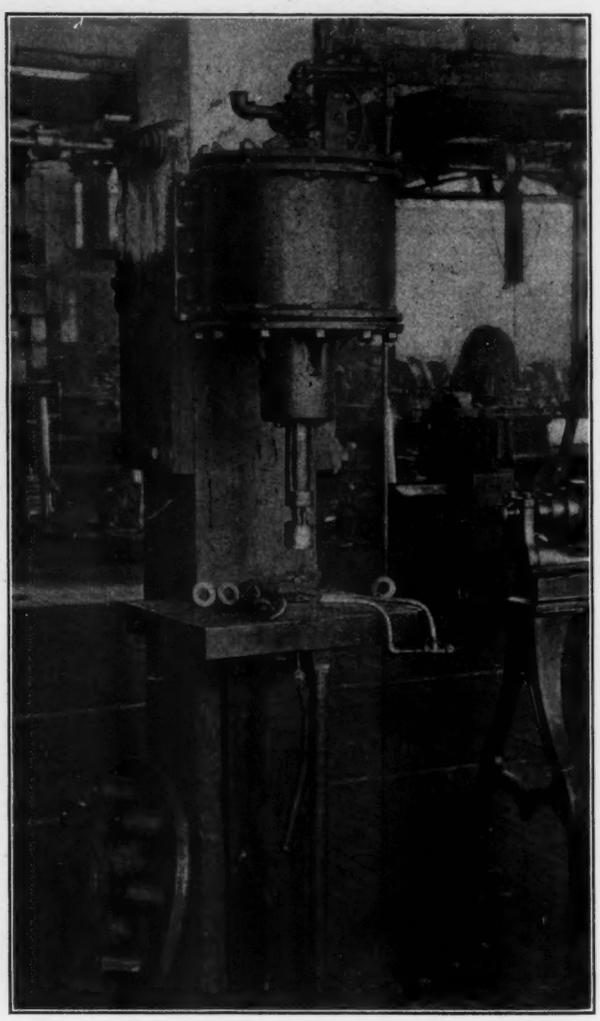
DETAIL OF JIG FOR DRILLING AND TAPPING ECCENTRIC STRAPS.

formerly required nine settings of a new strap and required two hours for its completion.

At the Readville shops a jig has been designed which permits all of this drilling and tapping to be done in one setting of the strap, the total time required being but one hour. This jig is shown in the accompanying illustrations and consists of a base plate secured to the side of the table of a radial drill. On this is mounted a circular plate of a size suitable to the straps to be drilled, which is free to revolve around its center connection to the base plate and carries straps and set screws for securing the eccentric strap. It is clamped to the base plate by a handle nut in the center and there is also a spring locking bolt that drops into the notches on the circumference of the circular plate, located in the proper positions to line up the different drilled or tapped holes. The plate, of course, can be revolved to other positions than those given by the locking bolt, if desired; in fact, it is capable of any adjustment in a vertical plane.

CUTTING GASKETS FROM OLD AIR HOSE.

Alternate layers of gaskets from old air brake hose and of sheet lead have been found to be a most satisfactory packing for throttle stems. As considerable packing of this kind is required at a busy terminal, at several places an air operated



AIR OPERATED PUNCH FOR MAKING THROTTLE STEM PACKING. THIS PACKING IS MADE FROM OLD AIR BRAKE HOSE AND FROM SHEET LEAD. THE HANDLE FOR CLAMPING THE HOSE WHILE IT IS BEING CUT IS SHOWN BELOW THE TABLE AND THE AIR PIPES FOR KEEPING THE BLOCK CLEAN ARE CLEARLY SHOWN.

cutter has been designed, the illustration showing an excellent arrangement at the West Springfield shops.

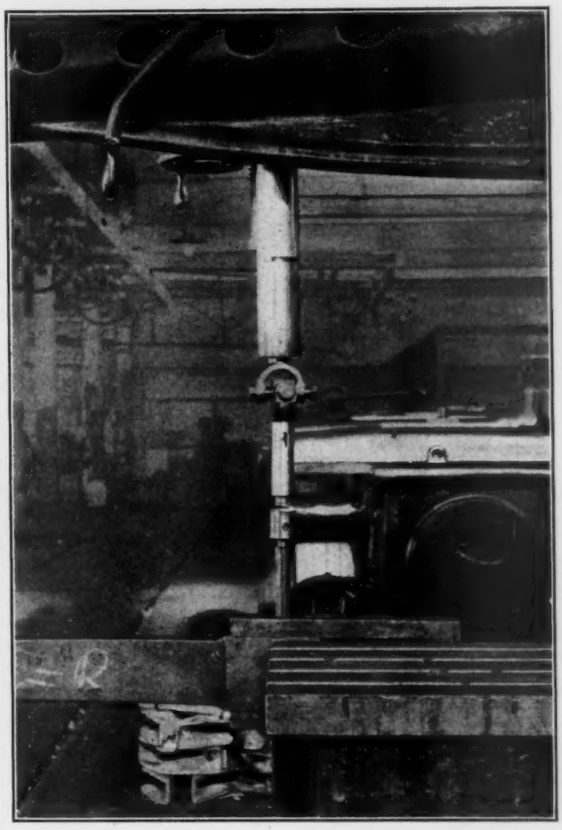
The cylinder is a 14 inch air brake cylinder mounted in a vertical position on a post, the piston of which is connected to the cutter. A three-way valve at the top is operated through gearing from a treadle located on the floor. On the bench the die is fitted with a clamp operated for holding the split hose by

means of the handle shown underneath. Air passages in the die are provided for blowing out the chips and dirt. The cutter is arranged with an internal spring and ring so that the gasket is forced off of it as it is released. Both lead and rubber gaskets are cut on this press.

SELF-ADJUSTING KNUCKLE FOR DRILLING AND REAMING.

For the purpose of preventing the careful calipering and readjustment of the work on the table of a drill press, especially an upright drill, when reboring and truing up rod brasses, a self-centering knuckle has been designed by A. L. Finnegan, general foreman of the shops at West Springfield.

This knuckle is also used when reaming the bolt holes on



UNIVERSAL JOINT USED FOR REAMING HOLES FOR STRAP END BOLTS. THIS PERMITS THE OPERATING HEAD OF THE DRILL PRESS TO BE SOMEWHAT OUT OF LINE WITH THE HOLES AND DECIDEDLY INCREASES THE RAPIDITY OF THE WORK.

strap end rods and other similar work. The illustration shows it on a radial drill in connection with the latter operation.

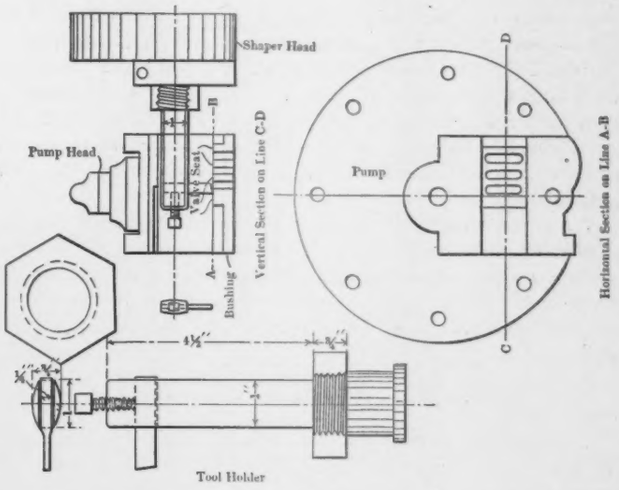
It consists very simply of two yokes of rigid construction pivoted on a central block with four arms at right angles. Each yoke has a very accurate fit and is given a side clearance of about ¾ inch. All bearings are carefully hardened and well lubricated. This will permit an offset in the vertical line equal to the clearance of the yokes and also acts as a universal joint permitting the reamer or cutter to center itself as the work requires.

This knuckle has been patented by its designer.

FACING MAIN VALVE SEAT OF AIR PUMP.

A plate with a rib is secured to the table of a shaper. This is provided with stud bolts in such a location that when the head of an air pump is secured to them the main valve seat is square and in line with the shaper head. A special tool holder somewhat resembling a boring bar is inserted in place of the tool clamp on the shaper ram and carries a small cutter at its outer end for facing the seat.

In this manner the valve seat can be accurately faced in a very short time, the table of the shaper being moved to give the feed and depth of cut required. The bolts holding the cylinder



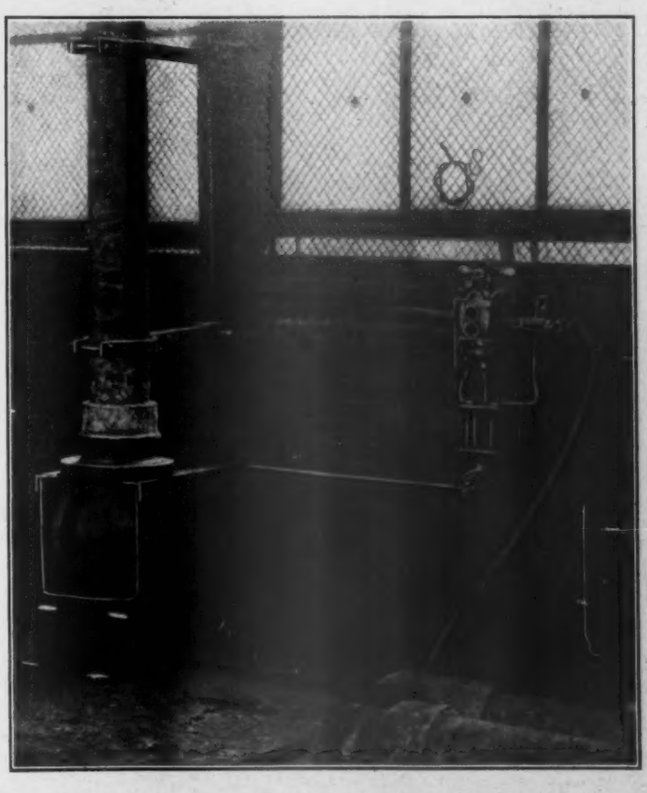
DETAIL OF JIG FOR FACING MAIN VALVE SEAT—WESTINGHOUSE AIR PUMP.

head to the plate pass through the holes in the head, which are in a standard position and thus assure the alignment of the valve seat with the shaper ram.

GRINDING DRY PIPE JOINTS.

A machine for grinding the joints between the dry pipe and T-head is shown in the accompanying illustration.

This consists of a framework made of plate and angles, which is mounted on a pivot secured to the small stand resting on the floor. The T-head is secured in this frame and the dry pipe is supported in a vertical position directly above, it being held by



GENERAL VIEW OF DEVICE FOR GRINDING DRY PIPE JOINTS.

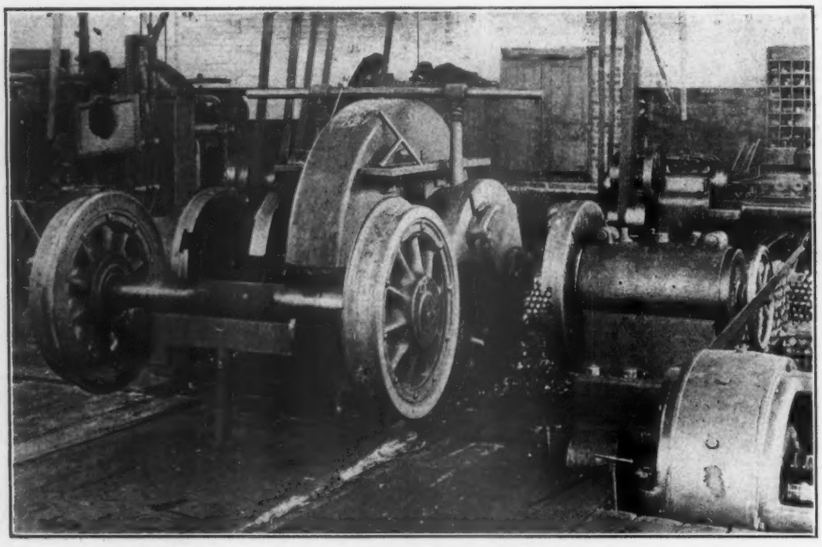
clamps extending out from the wall. A rod connects an arm from the frame to a crank connection on a short shaft in a brackets secured near by, that is driven by a small air motor.

The pivot supporting the oscillating frame can be raised and lowered a distance of a couple of inches by means of a small air cylinder located beneath it. In operation, after the pipe has been clamped in place and the T-head secured in the framework the oil and emery are placed on the joint and air is admitted to the small cylinder below which lifts the frame until practically the whole weight of the dry pipe is supported. The air motor is then started and the lower part oscillated at a fairly rapid rate and through a wide arc. Whenever it is necessary to renew the grinder the air is released from the lifting cylinder and the joint separated.

A similar arrangement has been designed for grinding the dry pipe in the front tube sheet. It works very much in the same manner as the one shown, the apparatus being secured in the front end. These machines were designed and are in use at the Collinwood shops of the Lake Shore & Michigan Southern Railway.

CHUCKING CAR WHEELS IN A LATHE.

It is the usual custom to set a car wheel lathe in a pit below the floor level, so that the wheels can be rolled directly into or out of the machine. This is usually done by rolling them up the inclined surface of wooden wedges so as to raise them high enough to permit the centers to enter and then drive the wedges out before chucking the wheel. This arrangement not only requires the service of two men, but is also attended by more or less delay in shifting the wheels to get the centers to enter properly.



VIEW OF AN APPLIANCE FOR PUTTING WHEELS INTO A WHEEL LATHE. THE AIR CYLINDER UNDER THE FLOOR IS OPERATED BY THE HANDLE INDICATED BY THE ARROW.

At several shops a pneumatic device has been arranged that eliminates this trouble. It consists simply of a frame hinged to the bed of the lathe, the outer end of which is raised by means of an air cylinder below the floor level. This frame is of such a width that it forms a track on which the axle can roll. In using it the wheels are brought up when the frame is in a lowered position, the air is turned on, it is raised up sufficiently to permit the wheels to roll into the lathe without assistance and in a position that the centers can be closed without further adjustment and the wheel chucked with the services of but one man.

In addition to this device at some shops the tail stock is also air operated and the centers can be thrown in or out by simply turning an air valve.

These two devices, together with standard tools, have been found to greatly increase the output of a wheel lathe.

WOOD'S LOCOMOTIVE FIRE BOX.

Fred H. Snell, employed by the William H. Wood Locomotive Fire Box & Tube Plate Co. as locomotive expert to follow the services of the three locomotives on the New York Central Lines which are equipped with this type of firebox, in a recent report to his employers said in part:

"I found in the first place that the locomotives fitted with the Wood's firebox, which were of the 2400 class, were being run in comparison with locomotives of the 2800 class, that had a larger firebox heating surface and a considerably greater height from grate to water bars. They were also fitted with brick arches and were the very latest type of locomotive, whereas the engines fitted with our firebox were of the older type fixed over. I wish to draw your attention to this as the railroad company's expert had reported the locomotive with our firebox as being about even on coal consumption. These comparisons, however, were made against the 2800 class, as stated.

"Upon my objection to this unequal comparison three of the 2400 class were substituted for the 2800 class and have been running in opposition to those fitted with our firebox and it is these locomotives that are referred to in my coal reports. You will note from these reports that our boilers are much better steamers and save a considerable amount of coal. The firemen have been changed on these engines from time to time, and as you will note from the tabulated reports, there has been little or no difference in the quantity of fuel used. The engineers and firemen who have run these locomotives speak in the highest praise in regard to the working of the boiler as against those not fitted with our firebox.

"The engineers tell me that they have not seen any tubes leaking when they had the engines in their charge, and from the careful examination I have given these boilers every day, up to the present time, I am satisfied that the tubes could be run for four or five months without putting an expander in them, and if it was not for the fires being dumped so often and the engines run into the roundhouses under their own steam, just taking cold air through firebox and tubes, they would go on working indefinitely without having any trouble from leakage.

"There has not been a broken staybolt since they were put into service. There was one defective throat sheet stay leaking, on account of it having the tell-tale hole drilled at an angle instead of straight in the center, which was replaced.

"After engine 2490 had been running nearly nine months, never missing a trip, I had a chance to examine it a number of times internally when the tubes were taken out, on account of the water being such that it honeycombed them very badly. I found the firebox and tube plates in first-class condition, and they do not scale any more than the regular plain fireboxes and tube plates. I also had occasion to examine engine 2494 when it was put in the shop to have the tubes fixed over, from same conditions. It was such a remarkable coincidence that they had not broken any staybolts in either boiler, that after the tubes had been put in again an order was issued for the drilling of twelve extra rows of radial staybolts, with 3/16 in. holes 2½ in. deep, to see whether any of the staybolts really were defective. This method is resorted to to find out whether the staybolts were in perfect condition.

"I am examining these boilers daily, after each trip, and they are showing up good. There have been no leaky or broken staybolts or leaky mud rings on any of the three boilers since I have been watching them. There have been several crown bolts leaking, from time to time, caused by dumping fires, but nothing of any consequence, and have easily been fixed.

"From the tabulated coal reports you will find that the saving is clearly shown to be over 15 per cent. and 20 per cent. over engines of the same class, for the same tonnage and the number of cars hauled.

"This report surely endorses your statement to me, that every extra square inch of surface put into the fireboxes and tube plates. by flanging, will give an account of itself in shape of fuel economy."

LEHIGH VALLEY R. R. TAKES UP FARMING.—An agriculturist is to be added to the staff of the Lehigh Valley Railroad Company. The officers of the company are of the opinion that more and larger crops can be raised on the farms along the line of the road, with proper instruction and encouragement. The new department begins work on April 1st, with F. R. Stevens, of Geneva, N. Y., at the head.

THE RAILROAD CLUBS.

CLUB	NEXT MEETING	TITLE OF PAPER	AUTHOR	SECRETARY	ADDRESS
Canadian	April 5	Efficiency in Transportation	D. Crombie	Jas. Powell	P. O. Box 7, St. Lamberts, Montreal, Que.
Central	May 13			H. D. Vought	95 Liberty St., New York
New England	April 12	An Address	Hon. John W. Weeks	G. H. Frazier	10 Oliver St., Boston, Mass.
New York	April 15	Stresses Developed by Collision of Freight Cars	B. W. Dunn	H. D. Vought	95 Liberty St., New York
Northern	April 22	Railway Clubs	J. W. Kreitler	C. L. Kennedy	401 W. Superior St., Duluth, Minn.
Pittsburgh	April 22	Run, Repair or Transfer	R. L. Kleine	C. W. Alliman	P. & L. E. R. R. Gen. Office, Pittsburgh, Pa.
Richmond	April 11	Train Lighting	Henry Schraeder	F. O. Robinson	C. & O. Ry., Richmond, Va.
Southern	April 21			A. J. Merrill	218 Prudential Bldg., Atlanta, Ga.
St. Louis	April 8	Freight Car Interchange	General Discussion	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	April 19	Electric Headlights	Prof. C. H. Benjamin	J. W. Taylor	390 Old Colony Bldg., Chicago
Western Canada	April 11			W. H. Rosevear	199 Chestnut St., Winnipeg, Man.

ELECTRIFICATION.

NEW YORK RAILROAD CLUB.

The report of a committee appointed by the president to consider the subject of electrification of steam railroads was read at the annual electrical night of this club on March 18. This report briefly reviewed the whole subject and gave a very broad and comprehensive view of the present status of electrification of steam railroads. It considered the subject under the following headings: history; characteristic features of electrification, under which the subjects of flexibility, effect of weather conditions, use of equipment, power, capacity, cleanliness and collateral advantages were considered; the reasons for considering electrification, that included a discussion of increase of facilities, increase of earnings and legislative enactment. The cost attending installation was the fourth division and included direct cost, contingent cost, ultimate cost and systems of electrification. The fifth chapter was on the advantages and disadvantages of electrification, which were enumerated carefully, following which the features to be considered for future electrification were briefly summed up and the report was closed with the following conclusions.

(1) No general information is available on the basis of which steam railroads, as a whole, would be justified in electrifying terminals or main lines, solely on the grounds of economy.

(2) Careful investigation is necessary to decide if electrification of terminals and suburban districts would be warranted in order to increase earnings.

(3) More attention should be given to the possibilities of electrification in connection with heavy grades, and at other places where an increase in facilities is needed.

(4) It is not likely that conclusive data on the economy of electrification will be available until electrification is extended over a complete steam locomotive stage.

(5) The electrification for passenger terminal and suburban service is now more or less settled as to method, but for freight and general trunk line service it is in the experimental stage.

(a) The types of locomotives for various service have not been determined, though progress is being made.

(b) The method of secondary distribution (working conductors), needs much development. The third rail is thoroughly reliable and efficient, but unsuitable for complicated switch work. In its present form it has only been used for voltages up to 1,200.

(c) The overhead system for high voltage working conductors also needs much development. Few, if any, are satisfied with present designs, and many changes are proposed.

(6) The steam railroad men and electrical engineers should work together in as close harmony as is possible so as to produce results that will be as free from mistakes and experiments as is possible in any developing art.

(7) Each problem must be studied on its merits and a decision can only be made after careful study of the conditions pertaining to each situation.

(8) The electrification of large freight terminals has not as yet been attempted, nor satisfactorily worked out, therefore it is necessary to proceed with caution in this matter and the problem must be exhaustively studied and new developments made before it would be justifiable to make such an installation. The electrification of any large freight terminal would involve a number of roads, and cannot be undertaken independently, without the co-operation of all the railroads affected, on account of the relations existing among the various roads in the interchange of freight traffic.

Committee—W. J. Harahan, Chairman; J. H. Davis, L. C. Fritch, Edwin B. Katte, Wm. McClellan, C. O. Mailloux, H. M. Warren, and G. W. Wildin.

Among those who discussed the report was George Gibbs, who stated that the system to be used should be adapted to the condition, and it is in no way possible to say that one system is better than another under all conditions.

L. B. Stillwell considered that the most important question now was to develop standards of electrification, mentioning three things that should be standardized in the near future. First, the position of the third rail; second, position of overhead trolley, and third, frequency.

W. S. Murray threw on the screen a number of lantern slides showing the latest development of the work on the New York, New Haven & Hartford electrified section. In addition he discussed the report very fully, disagreeing with the committee's findings in several respects.

G. M. Basford pointed out that the introduction of the Mallet compound locomotive had removed the necessity for electrification in many places. He also drew attention to the fact that the refinements of locomotive operation have not begun to be put into general use, and that these economical factors will be taken full advantage of before electrification becomes general. His whole discussion was woven around the fact that each particular instance that offered a possibility for electrification should be studied by itself and that it was not possible to arrive at any broad conclusions at the present time.

After the report had been discussed by several other members it was brought to a close by William McClellan, who pointed out very clearly that this report did not represent the complete ideas of any single member of the committee, but simply stood for what they were all able to agree upon.

ECONOMY IN THE OPERATION OF LOCOMOTIVES.

RAILWAY CLUB OF PITTSBURGH.

At the January meeting of this club J. R. Alexander, general road foreman of engines of the Pennsylvania Railroad, at Altoona, presented an excellent paper on the subject of "Supervision Tending to Economy in the Operation of Locomotives." In this paper he strongly urged the matter of education for enginemen, particularly firemen. The subject was one which brought forth an excellent discussion, that, in the main, agreed with the author in his contentions.

PASSENGER CAR LIGHTING.

CANADIAN RAILROAD CLUB.

At the February meeting there were presented several papers on the subject of passenger car lighting, each being prepared by an expert in one particular kind of lighting, who confined himself to his own specialty. This included a description of the

Commercial Acetylene Company's method of lighting; the Canadian Gold Car Heating & Lighting Company's acetylene lighting; a general paper by W. L. Gray on the Stone system of lighting, and a paper by L. R. Pomeroy on the Safety Car Heating & Lighting Company's method of car lighting by Pintsch gas. The latter paper was fully illustrated and forms an excellent brief treatise on modern Pintsch gas lighting.

At the March meeting of this club a paper by G. I. Evans on "An Experimental Articulated Mallet Locomotive," which appeared on page 81 of the March issue of this journal, was presented.

STEEL CAR CONSTRUCTION.

NEW ENGLAND RAILROAD CLUB.

In a very complete and well illustrated paper C. R. Harris discussed the construction of steel cars at the February meeting of the New England Railroad Club, giving a graphical analysis of the weight, cost, strength and general merits of pressed steel as compared with structural shapes for car structures, the comparison being very generally in favor of the latter construction.

The paper was discussed by Mr. Millar, Prof. C. F. Allen, Mr. M. V. Ayres and other members. The general consensus of opinion seemed to be in favor of structural shapes for car construction.

ELECTRIC CAR LIGHTING.

CENTRAL RAILWAY CLUB.

Mr. J. R. Sloan presented a most interesting paper on the above subject at the March meeting of this club. He first considered the general advantages of electric lighting and followed with a detailed discussion of the different types of electric lighting, pointing out in each case the advantages and disadvantages. It is the opinion of the author that a great majority of the future electric installations will be of the axle generator type.

STEEL FREIGHT CARS.

NORTHERN RAILWAY CLUB.

W. S. Atwood, mechanical engineer of the Dominion Car & Foundry Company, presented a brief but comprehensive paper on "Steel Freight Cars" at the January meeting of this club. A lively and interesting discussion followed, in which the experience of a large number of car experts was given.

STORES DEPARTMENT.

WESTERN CANADA RAILWAY CLUB.

The subject at the January meeting was "The Store Department and Its Relation to Other Departments," the paper being by A. E. Cox,. storekeeper of the Canadian Northern Railway. This paper briefly discussed the activities of the store department and pointed out its intimate relationship with other departments and how by the proper co-operation its work could be facilitated and its assistance to other departments be increased.

The discussion was active and brought out a large number of very interesting points on the practice in the various store departments of other roads.

ST. LOUIS RAILWAY CLUB.

At the April meeting the annual election of officers will take place. The nomination committee has placed the following gentlemen in nomination: President, J. E. Taussig; 1st vice-president, H. J. Pfeifer; 2d vice-president, Chas. Burlingame; 3d vice-president, J. B. Carothers; secretary, B. W. Frauenthal; treasurer, C. H. Scarritt; for member of executive committee, E. F. Kearney; for member of executive committee, W. H. Elliot.

RAILROAD PAY IN NEW YORK STATE.—The annual report of the Public Service Commission of the second district of the State of New York, for the year 1908, gives the average rate of pay received by the various employees of the railroads. For the railroad which has the largest number of employees, the figures are as follows:

	Number.	Average Pay per Day.
Engineers	2,015	$4.95
Firemen	2,023	2.88
Conductors	1,591	4.05
Other Trainmen	3,713	2,84

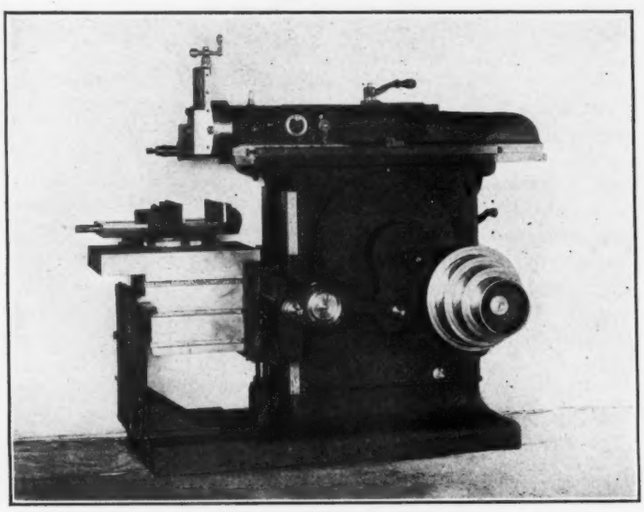
NEW 24-INCH SHAPER.

Stockbridge shapers are noted because of their two-piece crank motion that gives a stroke to the ram of even speed throughout the entire length of the cut and a very quick return stroke. Tests which have been made at the Worcester Polytechnic Institute indicate that 25 per cent. less power is required for the same amount of work with this type of shaper than with the plain crank motion type.

With the new 24-inch machine that has recently been designed and is shown in the accompanying photograph, this type of crank is again employed and the machine has been very carefully designed for ample strength and rigidity in all its parts. Some changes have been made in the detail construction, with the idea of simplifying the arrangement as compared with the previous machines.

As can be judged from the back gear ratio, which is 30 to 1, this machine is very powerful, but in addition to being a high duty shaper it also maintains the highest standard of accuracy.

Where previously a taper packing was used to take up the wear of the side thrust of the ram, on this machine there is a



24-INCH STOCKBRIDGE SHAPER EQUIPPED WITH A TWO-PIECE CRANK MOTION THAT GIVES A UNIFORM CUTTING STROKE WITH A VERY RAPID RETURN.

solid gib. This is bolted to the bed and when in place gives practically the same condition on both sides of the ram. The wear can be taken up by adjusting screws, the gib, however, being solidly bolted to the bed after being adjusted.

The cross feed mechanism has been simplified over the previous design and made stronger. The feed rod adjusts itself to any position of the bar and, without changing its position, feeds the table in either direction and automatically stops at either end of its feed.

The method of supporting the driving cone is also worthy of notice. It is carried on a sleeve supported by a large self-oiling bearing that takes all strain from the cone off from the driving shaft. A speed box with a single drive pulley can, however, be applied to the same shaper if desired, the parts being interchangeable.

With the cone pulley on direct drive the ratio is 8 to 1, but with the back gears in the ratio is 30 to 1. The cone gives eight changes of speed to the ram, with a range in strokes of from 8 to 90 per minute.

A few of the principal dimensions of this shaper, manufactured by the Stockbridge Machine Co., Worcester, Mass., are:

Actual length of stroke	24¼ in.
Vertical traverse of table	15 in.
Horizontal traverse of table	30 in.
Top of table	16 in. x 24 in.
Length of ram bearing in column	36 in.
Width of ram bearing in column	12 in.
Net weight of machine	4400 lbs.
Floor space required	102 in. x 52 in.

36 INCH MOTOR-DRIVEN LATHE.

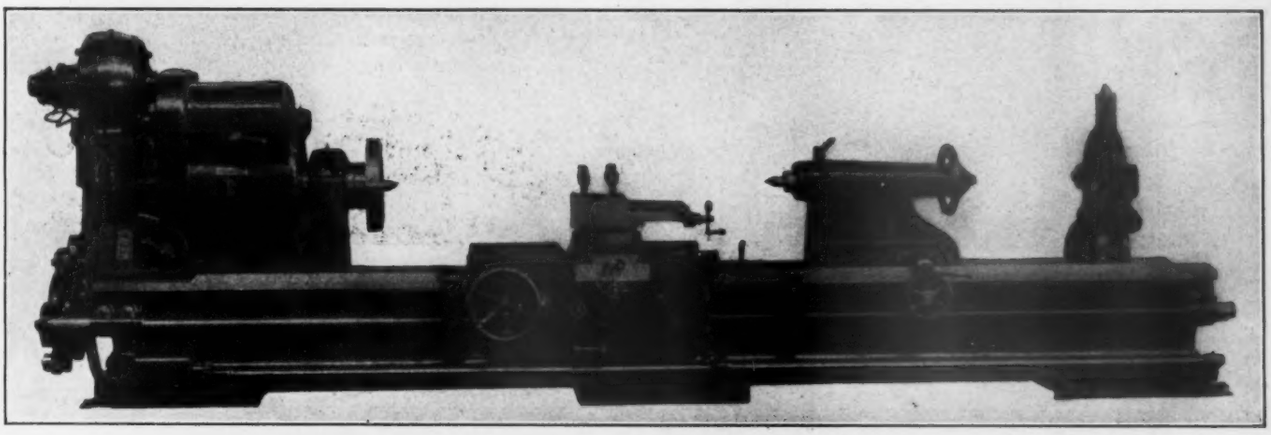
In all the recently constructed railroad shops the heavy machine tools are located so as to be served by the travelling cranes and are usually driven by individual motors either attached to the tool or located on the floor or column near by.

A large lathe that has the motor attached to the headstock and is carefully designed throughout for rigidity, power and ease of operation, is shown in the illustration.

This machine has a swing of 37 inches over the bed and 24 inches over the carriage. The driving motor is of 7½ horsepower and it has a speed range varying between 600 and 1,200 revolutions per minute. Special attention has been given to the design of the headstock, which is completely enclosed and of symmetrical proportions. This enclosed type of headstock not only lessens the danger of accident, but greatly adds to the massiveness and strength of this part. The driving mechanism is provided with gears having wide faces, and is strongly constructed throughout. There are six mechanical changes of speed, which, together with the changes obtained from the motor, give all the necessary speeds required for a lathe of this size.

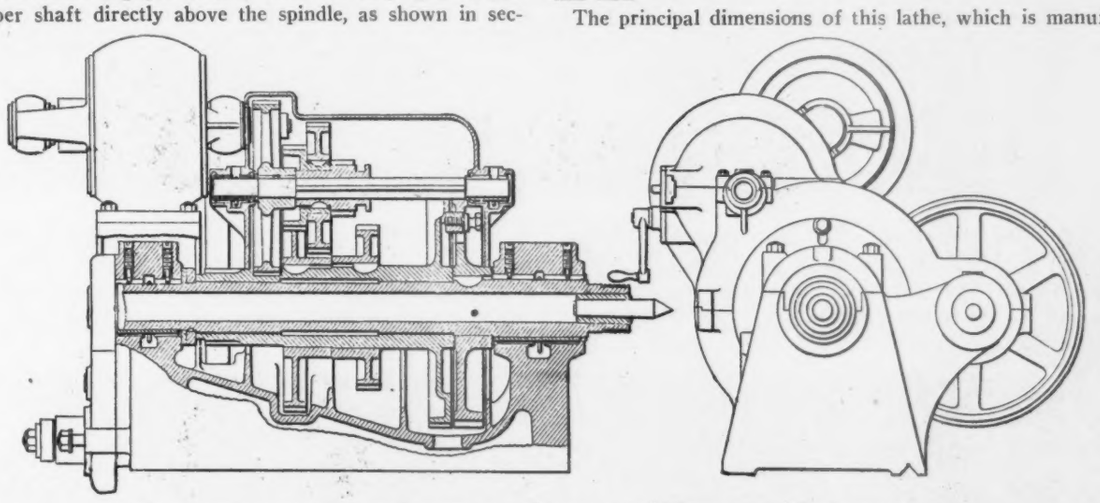
The manner of driving is as follows: A rawhide pinion mounted on the motor shaft engages directly with the large gear keyed to the upper shaft directly above the spindle, as shown in sectional view. This upper shaft also carries a sliding set of three gears adapted to engage individually with three gears on the spindle, and thus three speeds are obtained as with a three-step cone pulley. A rack and pinion are used to operate the sliding gears and the pinion is controlled by a handle on the front end of its shaft, which is shown in both views. These three changes of speed are doubled by the back gears, and additional speeds are obtained by using a variable-speed motor. In this way practically all the necessary speed range for a lathe of this size is secured.

The controller of the motor is mounted on the right side of the carriage, so that while it is convenient for the workman, it is not located so as to interfere with the operation of the lathe. As the illustration shows, this controller is connected through bevel gears to a splined rod extending the length of the bed, which transmits the movement to the starting box. This method of operating the motor from the carriage has proved so satisfactory that all the motor-driven lathes made by this company are so arranged. This lathe is adapted to cut threads ranging from 1/16 inch to 4 inches pitch. The lead-screw is prevented from sagging by a support which travels on the bed with the carriage and automatically stops off at certain points. This insures a longer life to the lead-screw and more accurate work from the machine. The lathe is equipped with power feeds for either longitudinal or cross movements, and, in addition, there is also power feed for angular positions of the compound rest. A dial in front of the headstock is so arranged as to give three changes of feed for screw cutting. There are also two intermediate positions in which the lead-screw remains stationary. This dial, together with a few change-gears, gives all the necessary changes ordinarily required for feeding or screw cutting on a lathe of this size.



36-INCH MOTOR DRIVEN ENGINE LATHE—SPRINGFIELD MACHINE TOOL CO.

The principal dimensions of this lathe, which is manufactured by the Springfield Machine Tool Co., Springfield, Ohio, are as follows:



MOTOR APPLICATION TO HEAD STOCK OF 36-INCH LATHE—SPRINGFIELD MACHINE TOOL CO.

Length of front journal, inches	10
Diameter of front journal, inches	6
Length of rear journal, inches	7
Diameter of rear journal, inches	4⅞
Hole in spindle, inches	3¼
Tailstock diameter, inches	4
Swing of lathe, inches	36
Length of bed, feet	18
Size of motor, horsepower	7½
Speed range of motor, rev. per min	600 to 1200

VIEW OF TWO 40-TON CRANES WHEELING A LOCOMOTIVE IN THE ROANOKE SHOPS OF THE NORFOLK & WESTERN RAILROAD.

GENERAL VIEW OF THE FOUNDRY AT THE ROANOKE SHOPS OF THE NORFOLK & WESTERN RAILROAD. SEVEN NILES CRANES ARE SHOWN IN THIS ILLUSTRATION. THREE ARE 15-TON CAPACITY, HAVING LATTICE WORK GIRDERS; THE OTHER FOUR ARE OF THE WALL TYPE.

A 30-TON NILES CRANE WITH A 68-FT. SPAN LIFTING A LARGE LOCOMOTIVE BOILER AT THE ROANOKE SHOPS.

RAILROAD SHOP CRANES.

Good crane service is so general in modern railroad shops that it seldom attracts any attention, but the installation of cranes at the Roanoke shops of the Norfolk & Western Railroad is so complete and extensive that it is deserving of some comment.

The erecting shop is provided with two 40-ton cranes, 59 ft. span, of the four motor type, that have a 5 ton auxiliary hoist, located on and forming part of the main trolley. The auxiliary operates at very high speed. These cranes, as well as the general view of the shop, are shown in one of the illustrations. They have no particularly unusual features, being of the double plate girder design, commonly used with this size crane. Two 30-ton cranes, of 68 ft. span, serve the boiler shop. These are of the three motor type, but provision has been made for the application of a high speed auxiliary hoist if desired at any future time. The bottom block of these cranes is provided with a special hook for accommodating the slings when one crane lifts an entire boiler, which operation is illustrated in the photograph. Three cranes of 15 tons capacity of the same general design as those in the boiler shop serve the general foundry.

It is in the wheel and soft iron foundry that unusual provision has been made for complete crane service. In this building there are nine electric cranes, three of these are of the lattice girder construction, 86 ft. 8½ in. span and 15 tons capacity. They are of the three motor type and cover the entire floor area of the main foundry. This type of construction is particularly well suited for this capacity of crane, and gives a very light dead weight for large capacity. On each side of the foundry there are two traveling wall cranes of 2-tons capacity and 25 ft. reach of arm. These run on a track extending the entire length of the building on both sides. One of these wall cranes on each side is of the stationary arm type equipped with a single hoist and operated by three independent motors controlled from a cage on the crane. The other two wall cranes are of the revolving type and arranged to operate by power through an angle of 90 degs. One of the illustrations gives a close view of both of these types of wall cranes. The revolving type are equipped with special four hook trolleys, each of which is operated by an independent hoisting mechanism equipped with a double disc brake. A special master controller in the cage is arranged so that any hoist can be operated independently or all in unison, as desired.

These cranes are used principally for conveying the wheels which are cast on either side of the foundry to a point where they can be picked up by the traveling crane, that passes over the annealing pits; this is also provided with a four hooked trolley. The wheels are thus carried four at a time and swung into positions so that when lowered they are located to permit the traveling crane to pick them up and convey them to the annealing pits without any moving by hand.

These cranes are electric driven throughout and were designed and constructed by the Niles Bement Pond Co., 84 Liberty street, New York.

REVOLVING TYPE WALL CRANE WITH A FOUR HOOK HOIST. THIS CRANE IS USED FOR TRANSPORTING WHEELS IN THE WHEEL FOUNDRY AND HAS A POWER CONTROLLED SWING OF 90 DEGS. ON EITHER SIDE OF ITS PRESENT POSITION. THE HOOKS ARE OPERATED INDEPENDENTLY OR IN UNISON, AS DESIRED.

RAILROAD RELIEF FUNDS.

The great extent to which aid is extended by workmen to each other through co-operative insurance and benefit funds or societies in cases of disability, death, or other adversity and the tendency of employers to assist in the support of such funds and to grant pensions to superannuated and disabled employees are shown in the twenty-third annual report of the Commissioner of Labor, just published. In connection with this report about 1,200 such funds were investigated by the Bureau of Labor.

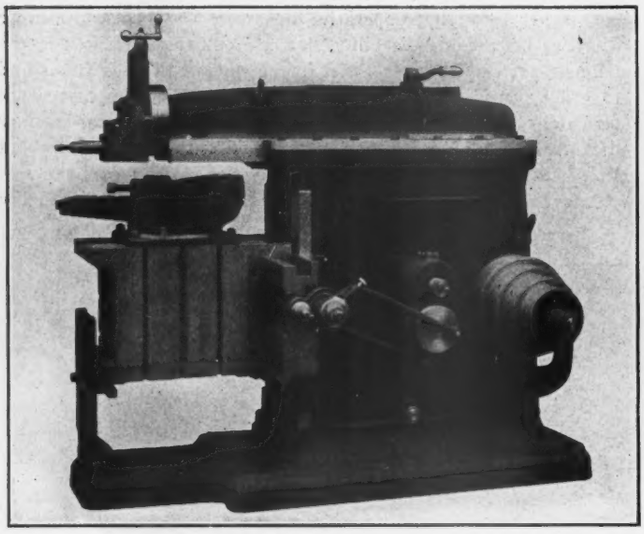
Information in regard to 50 railroad funds is included in the report. Of these, 14 are pension systems maintained entirely by the employing companies. Pensions are as a rule based on age and length of service, usually on the basis of 1 per cent. for each year of service of the average pay for the ten years next preceding retirement. In most of the systems pensions for superannuation are granted to employees retired at 65 or 70 years of age, after from 10 to 30 years of service, and for incapacity to employees 60 to 69 years of age.

Employees contribute all or a large part of the revenues of the remaining 36 funds investigated, 8 only being contributed to by the companies involved. One company contributes 50 per cent. of the revenue, and the remaining 7 amounts varying from 20 per cent. to less than 1 per cent. of the amount contributed by the employees. In these 8 funds there are provisions for relieving the funds from all claims for benefits if a suit for damages is brought against the company. Thirty-one of these 36 funds pay benefits for temporary disability, ranging from $2.50 to $20 per week. Thirty-four pay death benefits, the average payment per death having been $588. Several of these funds pay benefits in cases of permanent disability, and one pays a superannuation benefit.

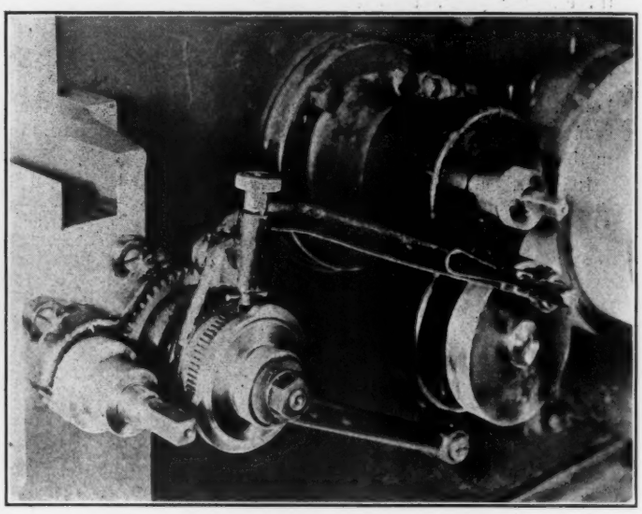
24-INCH BACK GEARED CRANK SHAPER.

It is the proportion of the power delivered by the motor or belt to the machine which appears as work at the point of the tool that in the long run determines the value of a machine tool. This is so because the tool which does deliver the largest proportion of power must of necessity be very rigid, well designed and accurately built. Of course the matter of convenience to the operator and range of adjustment are of great importance, and in practically all of the modern designs of tools have been given the attention they deserve.

The 24-inch back geared crank shaper shown in the illustration manufactured by the Queen City Machine Tool Company,



QUEEN CITY 24-INCH SHAPER WITH BELT DRIVE. NOTE THE LONG, LOW APPEARANCE.

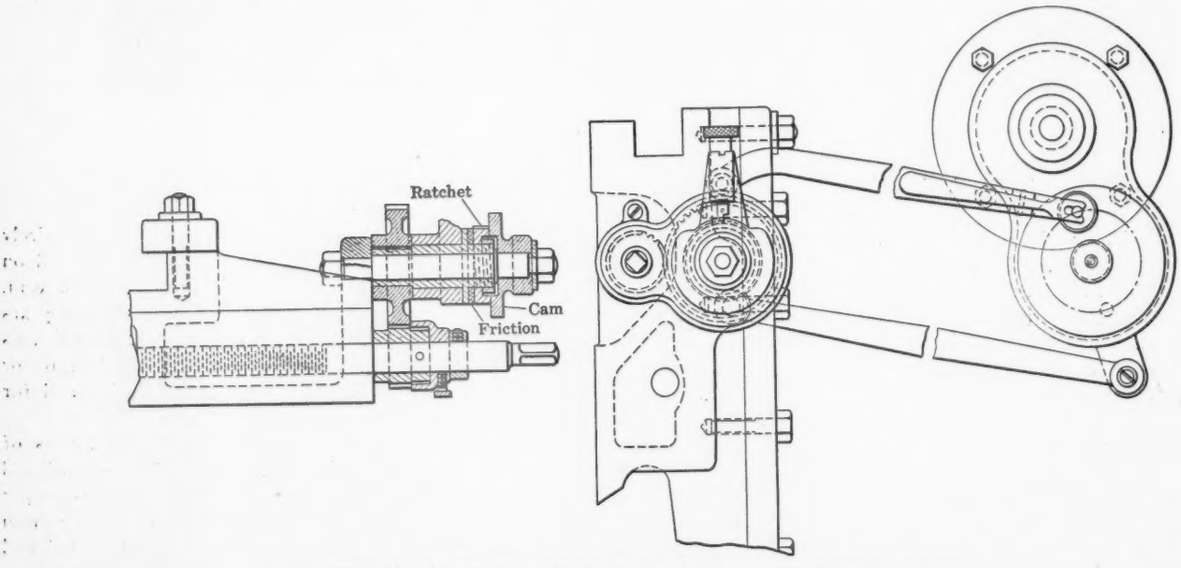


CLOSE VIEW OF FEEDING MECHANISM ON A QUEEN CITY 24-INCH SHAPER.

driven by a constant speed motor through a gear box (see *American Engineer*, May, 1908, page 196), removed 13 cu. in. of cast iron per minute with a 32 ft. tool travel, the highest rating of the wattmeter attached being 7 1-4 h.p.. This, it will be admitted, is a remarkably good record, and it is for the performance of such work as this continuously and with accuracy that the tool has been designed.

In the general arrangement the most noticeable feature is the extreme length of base, which is 17 in. longer than the average tool of this size, and the height over the ram, which is 6 in. less than the average. This not only makes it easier to reach the upper adjustment, but also gives a longer ram bearing in the column and a stronger and more steady operation of the tool. The tool is designed to give a cut in cast iron 1-2 in. deep by a 1-4 in. feed, which cut can be continued indefinitely with absolute accuracy.

Two features of the design are worthy of special comment, one being the automatic feeding mechanism and the other the table support. The former provides 16 changes of feed from 1-64 to 1-4 in., which can be made in either direction almost instantly while the machine is in operation. The feed rod is driven through gears, including a friction, from a ratchet on an auxiliary shaft. This ratchet is operated by a latch oscillated by the feed rod. The number of notches which are caught in each oscillation are determined by the position of the cam located next to the ratchet and adjustable by hand. This dog or latch can be lifted and by a half turn of a handle at the top can be held out of operation. To change the feed from the forward to the back stroke it is simply necessary to lift the plunger connecting the feed rod to the driving gear and allow this gear to travel half a revolution when the plunger will drop into the hole in the opposite side of the plate. The feed and distance rods act automatically as the height of the rail is changed. The feed screw has an adjustable graduated collar reading to .001 of an inch.



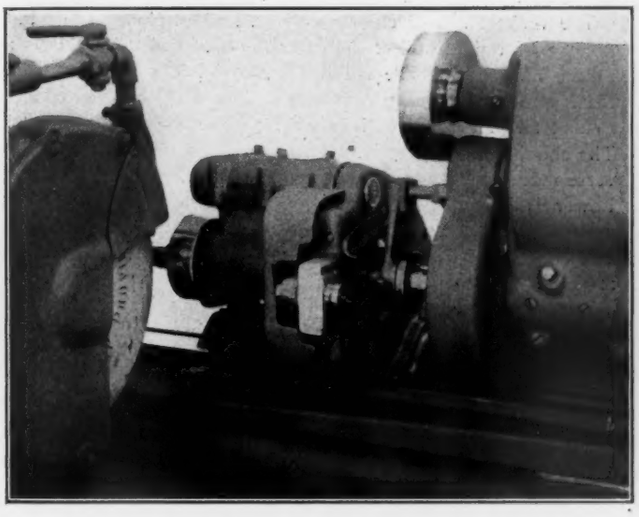
DETAILS OF FEEDING MECHANISM ON QUEEN CITY 24-INCH SHAPER.

The table support raises and lowers with the rail, is always

in line and needs no setting up. It is so arranged that no dirt can get in the bearing and its location at the extreme end of the table makes it particularly efficient. This feature has been given a large amount of study and it is believed that it is the most satisfactory arrangement that it is possible to obtain.

CAM GRINDING.

The accurate grinding of a large number of parts of irregular shape on a regular grinding machine can be accomplished by means of an attachment which has recently been designed by the Landis Tool Co., of Waynesboro, Pa., and is shown in one of the illustrations. This attachment is simply clamped to the table of the regular universal and plain grinders and the driving arm on the end of the spindle is connected with the regular driver on the face plate of the grinder. The attachment is constructed on the swinging principle, the spindle head being suspended from the hinged bearing located directly above. The work to be ground and the master cam are mounted on the same spindle.

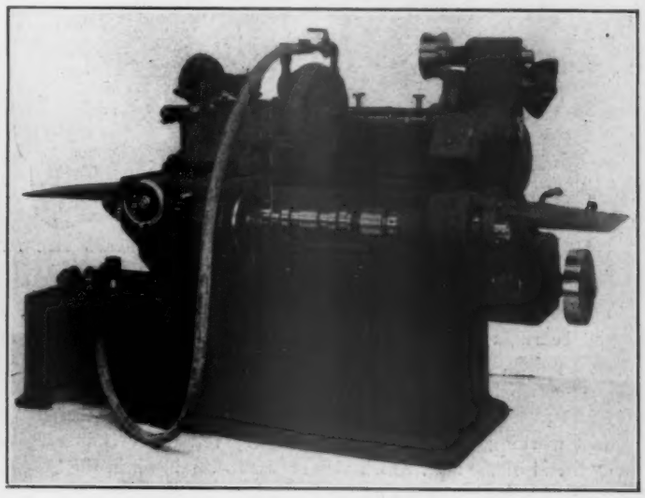


REAR VIEW OF ATTACHMENT TO PLAIN GRINDING MACHINE FOR GRINDING CAMS.

With this attachment the master cams are ground from actual size model cams. In doing this the master cam is mounted on the working end of the spindle, while the model serves as a master on the other end, this operation being exactly the same as illustrated for grinding the work. The master is enlarged, the cylindrical portion never being less than 3 in. in diameter; this in a majority of cases being more than double the size of the work.

The swinging or oscillating motion on the spindle is produced by the master cam working in engagement with a stationary guide, with which it is held in contact by a spring. The slight change in the cam form caused by the reduction of the diameter of the grinding wheel by wear is compensated for by a set of master cam shoe plates, that fit over the guide against which the master is held in contact. These are arranged in series to be changed at each 1 in. reduction in the size of the grinding wheel.

One of the illustrations shows a grinding machine that is designed specially for cam grinding, where the cams or eccentrics are integral with their shafts. With this machine working on gas engine cam shafts, master cams can be provided so as to grind the full set of inlet and exhaust cams at one setting. In this machine the principle of action of the grinding wheel and work for producing the cam form is reversed to that of the cam attachment of the regular machine. In this case the grinding wheel head moves by a cross reciprocating motion that is actuated by the master cam, and the work is carried by the regular stationary centres of the machine. The principle of compensating for wear is the same as in the attachment. This machine can be used for plain straight grinding whenever desired.

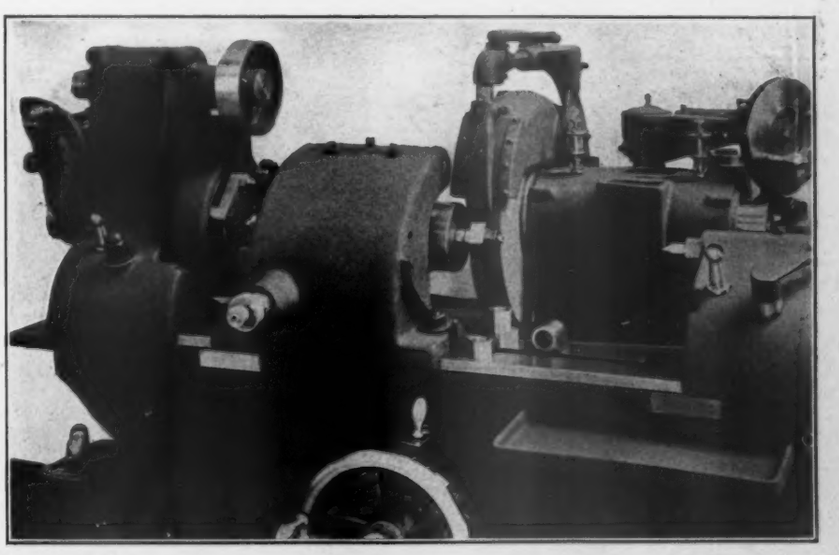


LANDIS MACHINE FOR GRINDING CAMS.

THE SELLS ROLLER BEARING.

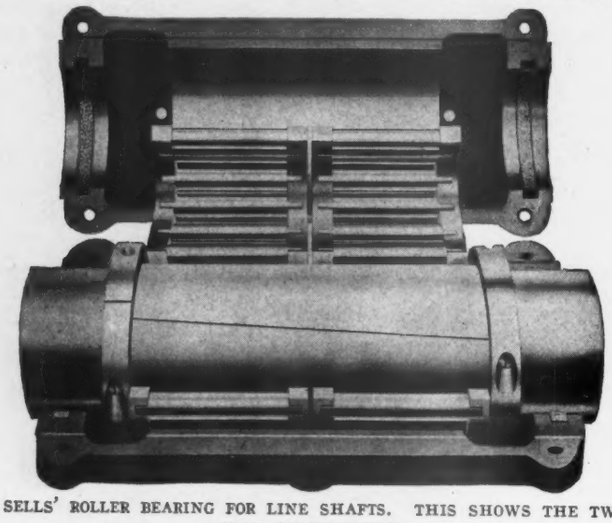
A new type of roller bearing, invented by John D. Sells, for many years with the Standard Roller Bearing Co., and now manager of the Royersford Foundry & Machine Company, Royersford, Pa., is shown in the illustration. The particularly novel features of these bearings are their universal adaptation, the ease with which they may be substituted for the old style bearings, and the interchangeability of all parts.

The bearing consists of four parts—a split bushing, a split collar to clamp this bushing to the shaft, a split cage for containing the rollers, and finally a split box to inclose the other three parts. The split bushing is of hardened steel and is designed to prevent the shaft from becoming cut and scored by the case hardened steel rolls. These bushings are furnished in different thicknesses, so that each size of bearing is adaptable to three different diameter shafts. This permits a user a certain latitude in making changes and does not require the dealer to



FRONT VIEW OF ATTACHMENT TO PLAIN GRINDING MACHINE FOR GRINDING CAMS.

handle a large stock to cover all possible requirements. Any bearing of a given size can be fitted to any ceiling or wall hanger or pillow block of a corresponding size, either for a new installation or for replacing old style plain or self-oiling bearings.



SELLS' ROLLER BEARING FOR LINE SHAFTS. THIS SHOWS THE TWO CAGE ARRANGEMENT.

For replacements it is not necessary to dismantle the shafts, as the bearings are split and as easy to apply as a steel or wood split pulley. The same advantage exists in new equipment.

The two halves of the bearing are fitted together with milled joints to make them dustproof. As a further preventive against dust working into the bearings a heavy felt wiper is inserted in each end of the box, which also serves to retain oil in the bearing. Tapped holes in the top of the box allow the attaching of oil cups, and drain holes are drilled so that the box may be flushed with kerosene or other cleansing fluid if the oil should thicken or gum.

For shafts 3 11/16 in. in diameter or larger a double roller cage of the type illustrated is employed to provide a larger and more suitable bearing surface. For ordinary shafting only one cage with a box of sufficient length to cover it is used. Another advantage of these bearings is that all parts are interchangeable. Thus should any part of the bearing become mislaid or accidentally broken it may be easily replaced and the expense of a complete new box is saved. This interchangeability is also an advantage where it becomes necessary for any reason to change the bearings of a shaft. If the load is too heavy for a single cage all that need be ordered to provide for the increase is another single cage and a suitable box.

COMBINED CAR MORTISING AND BORING MACHINE.

In a number of instances it has been found very advantageous to locate wood working tools for heavy work so that two or more operations can be carried on at the same time, or at least consecutively. This is usually done by arranging a common carriage table so that when the sill or other part is clamped in place several operations can be performed upon it as it is carried along the table. The illustration shows a combined car mortizing and boring machine arranged in this manner.

The Hamilton five spindle boring machine used in this case was fully illustrated and described on page 213 of the May, 1909, issue of this journal; reference to this article will show its many excellent features and arrangements.

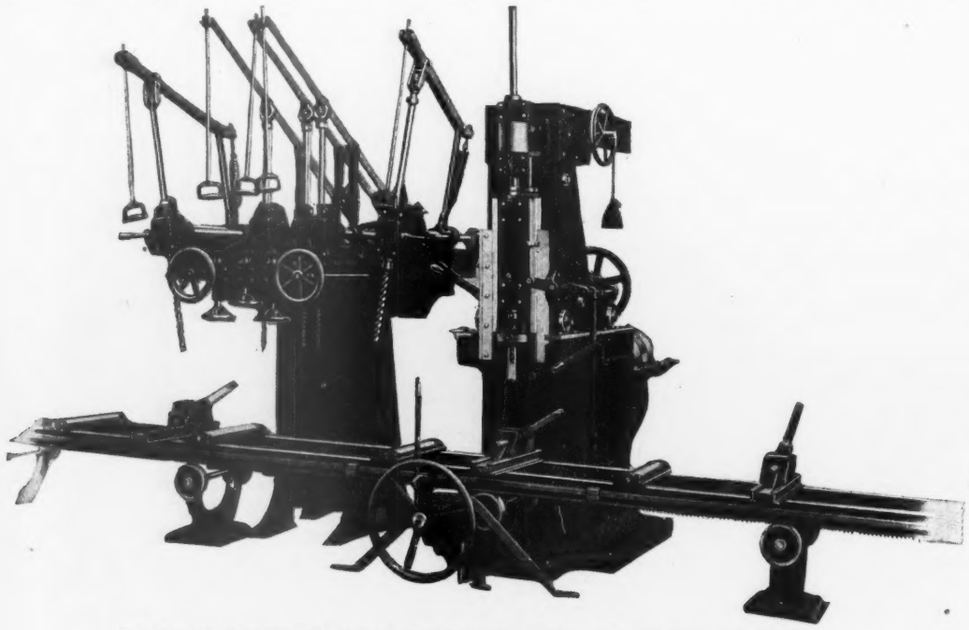
The vertical hollow chisel mortiser, located alongside of it, is designed for the heaviest character of work and takes chisels up to 2½ in. square. The chisel ram, 29 in. long, is mounted in the front of the housing in dove tail slides and is counterbalanced so that all of the weight is taken from the working mechanism. The chisel ram has a 17 in. vertical movement and a 16 in. transverse movement across the carriage, and will mortise 6 in. deep. Power is imparted by a train of gearing and reverse friction pulleys, all placed outside for ready inspection and adjustment. The cutting speed of the chisel is 13 ft. per minute, with a return at double this speed.

The table common to both these machines is of steel beam construction, of very rigid character, which will clamp material 20 in. wide by 16 in. thick. It is provided with quick acting eccentric clamps and has both a power and hand feed.

The Bentel & Margedant Co., Hamilton, O., in addition to this combined mortising and boring machine, also have combinations, similarly arranged, of mortising and gaining machines and of gaining and boring machines.

THE STURTEVANT DUST BLOWING SET.

For blowing dirt and dust out from machinery and from around motors, switchboards, shelving, and other places difficult or dangerous of access, the B. F. Sturtevant Company, Hyde Park, Mass., has designed a new portable dust blowing set. The device is electrically driven and weighs only 55 lbs. It is adapted for attachment to lighting sockets, so that the range of its usefulness is very broad.



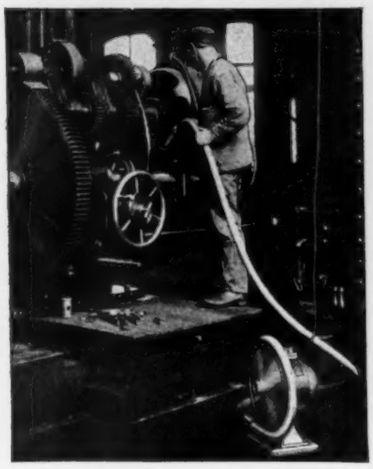
HAMILTON COMBINED HOLLOW CHISEL, MORTISING AND BORING MACHINE.

While the blower does not give as high a pressure as the large compressed air systems, the larger volume of air accomplishes in most cases the same purposes without the hard, severe blast.

There is an additional advantage derived from the larger volume of air in the speed with which the work is accomplished.

The set includes a 12-ft. length of 1¼ in. flexible reinforced air hose and a 10-in. aluminum nozzle. A 20-ft. electric light cord gives a working radius of 32 ft. from a lighting socket.

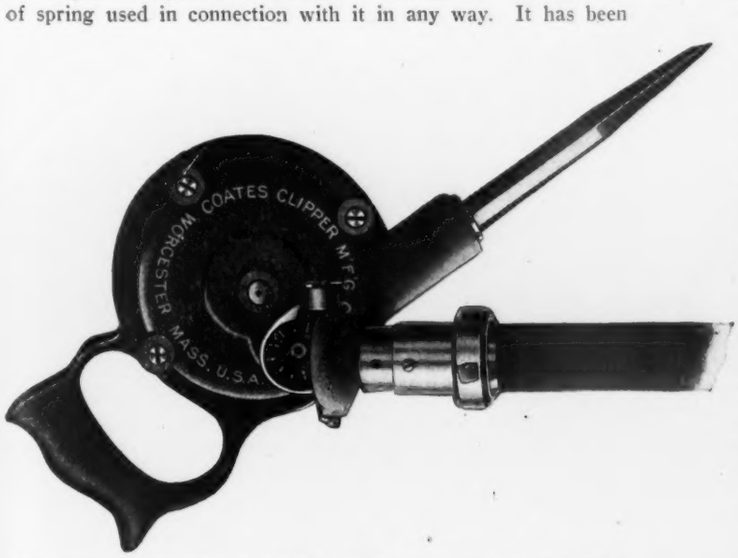
As a vacuum cleaner the set may also be employed for suction cleaning where a dust collector is not necessary. For this work one end of the hose is attached to the inlet of the fan, while the vacuum cleaner tool is attached to the other. The fan will suck the dust through the wheel and discharge it at the outlet or through a hose connected thereto which is led out of doors.



STURTEVANT BLOWER CLEANING LARGE MACHINE TOOL.

MECHANICAL CHIPPING HAMMER.

A chipping hammer which is entirely mechanical in its operation is shown in the illustration. This hammer is operated by a Coates flexible shaft attached to a ½ h.p. motor and strikes a blow equal to a pneumatic hammer. There is not a valve, lever of spring used in connection with it in any way. It has been very carefully tried out on various kinds of work and has given good satisfaction in every case. Riveting heads can be substituted in place of the chisels and the same outfit can be used for riveting.



MECHANICAL CHIPPING HAMMER DRIVEN BY A COATES FLEXIBLE DRIVE.

One of the surprising features of using a hammer of this kind is the cost of operation. The motor being ½ h.p., it is figured out that the actual current consumed per hour in operating the hammer is about 330 watts. At the prevailing price of electric current for power, the cost of operating would be less than 3 cents per kilowatt hour.

This is only one of the recent additions to the already numerous tools and devices made by the Coates Clipper Manufacturing Co., of Worcester, Mass., in which its flexible shaft is employed to transmit the power. This same outfit can be used for drilling, grinding and scratch brushing, preparing rails for bonding, doing repair work on locomotives and similar classes of work.

EXAMPLE OF WORK DONE BY A MECHANICALLY DRIVEN CHIPPING HAMMER.

SASH OPERATING IN SHOP BUILDINGS.

The mechanical control of a few or a hundred pivoted and hinged sash in the modern industrial building is readily accomplished with the "Straight Push" Sash Operator.

This is the latest device of this character to be patented and placed on the market, and is designed to be nearly fool-proof and to open sash under varying conditions without getting out of order. It is manufactured by the G. Drouvé Company, of Bridgeport, Conn.

A sash operating device in shop service must be built to stand handling by many different operators and considerable abuse comes quite naturally. Pivoted windows are not always made to fit their frames without binding and the changes of weather and swelling of the wood often makes the use of a chisel and hammer necessary to open them. The man that comes to operate the sash very seldom takes these facts into consideration and as he gets heated and the device refuses to answer to his efforts, he either gets assistance or his own strength reinforced by an iron bar, this particularly where worm and gear is used, causes something to break, usually the apparatus.

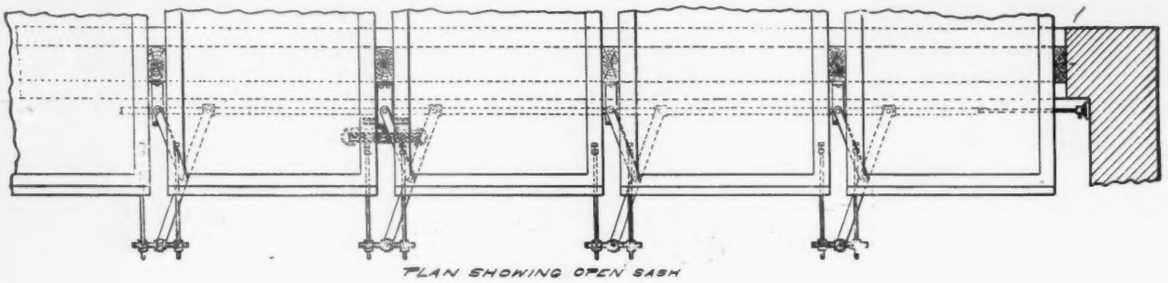
The G. Drouvé Co. have been manufacturing and installing sash operating devices for a number of years and the success with which the "Lovell" push-and-pull type met from the start and its general specification today, with over 400,000 feet in use, has given the company some experience and facts that have been taken advantage of in the design of the new "Straight Push" Operator.

The direct pushing outward of the sash with two half-inch steel rods by leverage, one arm being fastened to each side of the sash at the lower part of side rail insures an opening of the window. These two arms are adjustable to give a 30 deg. or 45 deg. opening.

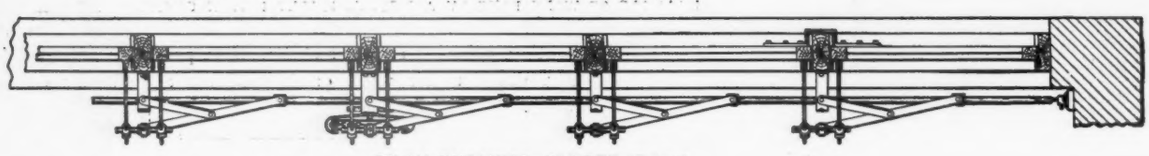
A line of ¾-inch pipe shaft to which is fastened the main lever at each sash with an open coupling, is moved backwards and forwards between spool roller brackets secured at each interval between windows. A rack and pinion with geared wheel, controlled by a chain from the floor, gives the forward and return movement.

A guide lever is secured to the top of each bracket and in turn is fastened to the main lever. The unattached end of main lever has a U-chair riveted to it which supports the shaft connecting the two steel arms. While the arms bind to the connecting shaft it works freely in the U-chair support, allowing the arms to follow the inclination of the sash.

The movement back or forth of the main shaft operates the levers at each window and as all arms work simultaneously, the arms being directed straight at each side of sash, the windows open or closed as desired—quickly, surely and each window has the same power applied. As no lost motion occurs the farthest window on the line oerates in unison with the first.



PLAN SHOWING OPEN SASH



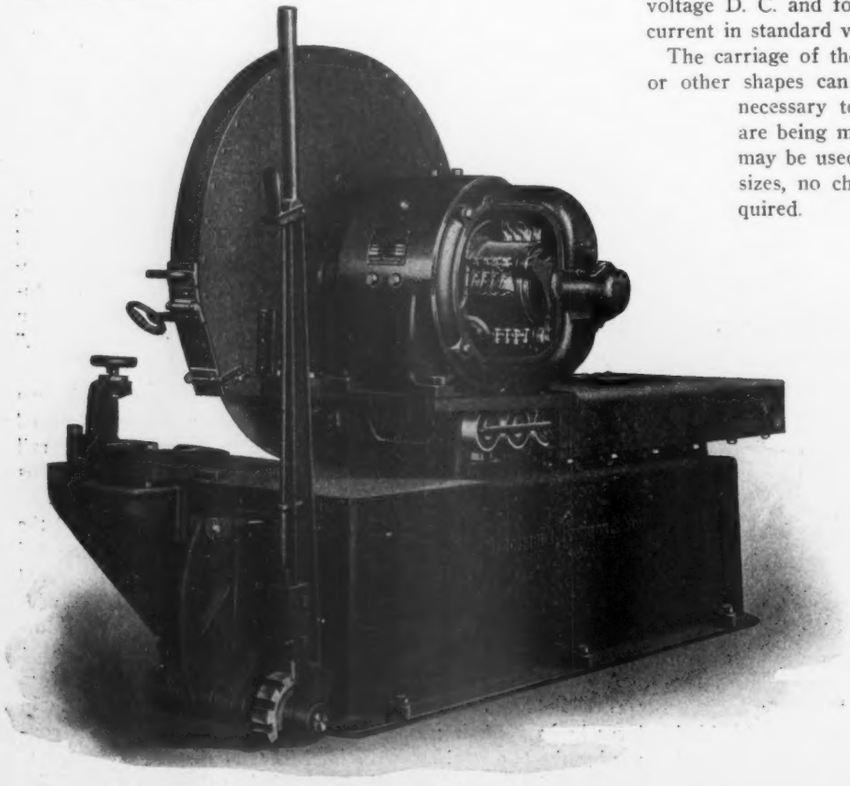
PLAN SHOWING CLOSED SASH

"STRAIGHT PUSH" SASH OPERATOR.

Several different sizes of wheels are made which gives the increased power required as the number of sash to be operated is increased. Any number from 10 to 100 or more sash are easily placed under one control with this operator.

The material is heavy and the few connecting couplings are simple and of substantial strength to withstand strain as well as to resist the corrosive effects of gas and acid fumes.

The apparatus is adapted to operate pivoted side or pivoted top-and-bottom sash, hinged-at-the-top or hinged-at-bottom sash. The operating parts which are very few cannot rust together, as the connections are phosphor bronze-to-iron, the same principle being carried out as is applied to pipe unions for steam service. This insures its operation at any time.



RYERSON HIGH-SPEED FRICTION SAW.

HIGH SPEED FRICTION METAL SAW.

Since metal has entered so extensively into car construction there has arisen a general demand for some method of quickly cutting up steel sections, small bars, etc. Most of the friction saws that have been available have been too large and expensive for this work.

Recognizing this condition, and at the request of a number of railroad mechanical men, Joseph T. Ryerson & Son, Chicago, have designed a high-speed fricton saw which is particularly adapted for this purpose. It is a remarkably simple machine and has a capacity for cutting continuously 15 in., 80 lb., I beams without turning the beam. It will cut such a beam in from 28 to 38 seconds. It needs no special foundation, and requires a floor space of but 7 x 4 ft.

A 52 h.p. motor, that is the result of several years of experimental work by a leading electric company, is direct connected to the saw. These motors are designed for practically any voltage D. C. and for 60 cycle two and three phase alternating current in standard voltages.

The carriage of the machine is arranged so that small beams or other shapes can be cut at an angle. In doing this it is necessary to clamp the work, but when straight cuts are being made no clamping is required. The machine may be used in rapid succession on various shapes and sizes, no change or adjustment of any kind being required.

REPACKING JOURNAL BOXES.

The most important feature of the lubrication system consists of the systematic repacking of journal boxes. As cars pass over the repair tracks, or stand on loading, unloading or storage tracks, the old packing should be removed from all of the boxes and replaced with fresh packing. This work should be done at least once a year, and journal boxes should be stenciled with the date the boxes are repacked, so that the work may be continued in a systematic manner. The old packing removed from the journal boxes should be put into a vat of hot oil, and thoroughly washed, and cleansed of all impurities. It should then be thrown upon a screen, and the surplus oil drained off, so that

after being shaken out and handled again by hand it is ready for use again. This renovating process removes all the sand, cinders, heavy grease, babbitt, and all foreign matter, from the waste, changing it from a heavy, soggy mass to a light, fluffy condition. This work is all done by a man with a hay fork.

The device I am describing is a hot oil soaking vat, or waste cleaning machine, now in general use on two of the leading railways in the West. It consists simply of a metal vat resting upon, or completely surrounded by, steam or hot water pipes, with the drain pans kept hot by the pipes. Under no circumstances should the steam or hot-water pipes be placed inside of this vat, on account of the heat from the pipes evaporating the lighter parts of the oils. This vat is quite inexpensive.—*William J. Walsh before the New England Railroad Club.*

INTERNATIONAL RAILWAY FUEL ASSOCIATION.

CONVENTION—LA SALLE HOTEL, CHICAGO, MAY 23 TO 26.

The chairmen of the various committees will be glad to have circular letters that have been sent out answered and returned as soon as possible. They are all very busy men and should be given every assistance possible in getting the reports completed at an early date.

THE ENGINEERS' SOCIETY OF PENNSYLVANIA will hold its second annual convention in Harrisburg on June 1st, 2d and 3d. The success attending the convention and exhibit last year was so great as to warrant making special efforts this year to increase the size and scope of both. The exhibit will be held in the new reinforced concrete building of the Central Pennsylvania Tracton Company, Cameron and Forster streets, Harrisburg, where approximately 26,000 square feet of ground floor space is available.

"The Thermal Conductivity of Fire-Clay at High Temperature," by J. K. Clement and W. L. Egy, issued at Bulletin No. 36 of the Engineering Experiment Station, University of Illinois, is a report of the results of experiments on the thermal conductivity of several commercial fire-clays at high temperatures. A detailed description of the instruments and methods of high temperature measurements is included. Copies of the Bulletin may be obtained gratis on application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

More than 60,000 people and institutions own the stock of the Pennsylvania Railroad.

PERSONALS.

P. C. Withrow has been appointed mechanical engineer of the Denver & Rio Grande, with offices at Burnham Station, Colo.

L. O. Jackson has been appointed mechanical superintendent of the Beaumont & Great Northern, with office at Onolaska, Tex.

J. W. Lowery has been appointed master mechanic of the Tombigbee Valley, with office at Calvert, Ala., succeeding F. P. Brooks.

F. H. Neward, master mechanic of the Pontiac, Oxford & Northern (Grand Trunk), with office at Pontiac, Mich., has resigned.

W. J. Bingley succeeds Mr. Tritsch as master mechanic of the Maryland division of the Western Maryland, with office at Hagerstown, Md.

E. W. Pratt, assistant superintendent of motive power and machinery on the Chicago & Northwestern Ry., has been transferred from Chicago to Clinton, Ia.

J. W. Small has been appointed superintendent of machinery of the Kansas City Southern, with office at Pittsburg, Kan., succeeding F. R. Cooper, resigned.

D. M. McKenna has been appointed foreman of the car department of the International & Great Northern, with office at Palestine, Tex., succeeding W. E. Looney, resigned.

H. C. Stevens has been appointed master mechanic of the Fourth division of the Denver & Rio Grande, with office at Alamosa, Colo., succeeding J. H. Farmer, transferred.

W. E. Woodhouse, master mechanic of the Canadian Pacific at Calgary, Alb., has been appointed shop superintendent at Winnipeg, Man., succeeding S. J. Hungerford, resigned.

R. P. C. Sanderson has resigned as superintendent of motive power of the Virginian Railway to become general superintendent of the new plant of the Baldwin Locomotive Works at Eddystone, Pa.

J. H. Farmer, master mechanic on the fourth division of the Denver & Rio Grande at Alamosa, Colo., has been appointed master mechanic of the Rio Grande Southern, with office at Ridgway, Colo.

G. H. Emerson, superintendent of motive power of the Great Northern, at St. Paul, Minn., has been appointed assistant general manager, with office at St. Paul, succeeding H. A. Kennedy, resigned.

C. M. Tritsch, master mechanic of the Maryland division of the Western Maryland at Hagerstown, Md., has been appointed superintendent of motive power and car departments, suceeding R. C. Evans, resigned.

W. H. Wilson, superintendent of motive power of the Buffalo, Rochester & Pittsburgh at DuBois, Pa., has resigned, effective April 1, to enter the service of another company, with headquarters at St. Paul, Minn.

M. K. Barnum, who since July, 1904, has been general inspector of machinery and equipment on the Chicago, Burlington & Quincy R. R., has been appointed general superintendent of motive power of the Illinois Central R. R., with headquarters at Chicago, effective April 1.

The mechanical department of the Great Northern, formerly in charge of G. H. Emerson, has been divided, and two superintendents of motive power have been appointed. R. D. Hawkins, formerly assistant superintendent of motive power, has been appointed superintendent of motive power, with jurisdiction over the mechanical and electrical forces, other than locomotives and car shops, and A. C. Deverell, assistant superintendent of motive power, has been appointed superintendent of motive power, with jurisdiction over locomotives and car shops.

Samuel J. Hungerford has been appointed superintendent of rolling stock of the Canadian Northern, with office at Winnipeg, Man. Mr. Hungerford was born July 16, 1872, at Bedford, Que. He began railway work as a machinist apprentice in May, 1886, with the Southeastern Railway, now a part of the Canadian Pacific, at Farnham, Que. He was then consecutively machinist apprentice, machinist, round-house foreman, locomotive foreman, general foreman, master mechanic and superintendent of locomotive works at Winnipeg. Since January, 1908, he has been superintendent of shops at Winnipeg, which position he resigned to become superintendent of rolling stock of the Canadian Northern and the Duluth, Rainy Lake & Winnipeg, with office at Winnipeg.

CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

CAR ROOFING.—A circular from H. W. Johns-Manville Company, describes the J-M Car-Best-Us car roofing.

LIFTING MAGNETS.—A leaflet, which by means of a large cross section describes the detail construction of a lifting magnet of large capacity, is being issued by the Cutler-Hammer Clutch Company, Milwaukee, Wis.

BOLT CUTTERS.—A leaflet which illustrates and briefly describes the automatic opening die head now being furnished to bolt cutters, nut tappers and pipe threaders by Wells Bros Co., Greenfield, Mass., is now ready for distribuiton.

VALVES AND FITTINGS.—A 120-page illustrated catalog has just been issued by the Watson-Stillman Co., 50 Church St., New York, which, it is claimed, lists more types and combinations of hydraulic valves and fittings than have ever before been included in a single catalog.

MOTOR DRIVEN AIR COMPRESSORS.—Publication No. 387 of the National Brake & Electric Co., Milwaukee, Wis., is exclusively devoted to a detailed illustrated description of the National motor driven air compressors, which are noticeable for their simplicity, reliability and high efficiency.

SANITARY EQUIPMENT.—A catalog which illustrates the latest design and arrangement of sanitary equipment for shops, including toilet room facilities, metal lockers, steel shelving, work benches, and drawing stands, is being issued by the Manufacturing Equipment & Engineering Company, Boston, Mass.

VANADIUM IN FRENCH AND GERMAN.—The American Vanadium Company, Frick Building, Pittsburgh, Pa., is issuing a completely illustrated catalog descriptive of vanadium products and containing detailed instructions for the use of vanadium under various conditions, in either the French or German language.

TOOL STEELS.—A book being issued by E. S. Jackman & Company, 710 Lake St., Chicago, discusses the features and advantages of the Firth-Sterling tool steels, dealing with water hardened steels exclusively. It includes directions for judging heats by magnets, the proper method of tempering and other similar information.

OIL STORAGE SUGGESTIONS.—A small leaflet is being issued by Gilbert & Barker Mfg. Co., Springfield, Mass., that contains five suggestions in connection with oil storage. Illustrations of typical installations for railways are included. The system manufactured by this company includes underground tanks and self-measuring pumps.

STEAM METERS.—Bulletin No. 4720, recently issued by the General Electric Company, describes in considerable detail, steam and air flow meters. These meters will give an automatic record of the flow of steam, in pounds per hour, through pipes of any diameter and at any temperature, pressure or degree of moisture met in commercial practice.

BELMONT PACKING.—The Clement Restein Co., 133 N. 2nd St., Philadelphia, is issuing general catalog No. 3, comprising 150 pages, that illustrates and describes in a very attractive manner, packing, hose and gaskets to meet practically every conceivable condition. This catalog is one of the most complete that has ever been published on these products

JACKS.—A very interesting and complete catalog, covering 48 pages, is being issued by Fairbanks, Morse & Co. It is numbered 109 B and fully illustrates and describes the Barrett patent compound lever jacks, ball bearing and roller bearing screw jacks, as well as Duff-Bethlehem hydraulic jacks. These are furnished in special designs to suit all railroad uses.

STEAM TURBINES.—Bulletin No. 176 of the Sturtevant engineering series, issued by the B. F. Sturtevant Co., Hyde Park, Mass., deals with the subject of steam turbines for driving ventilating fans, blowers, or generator sets. This company manufactures complete direct-connected units of this character in many sizes. The bulletin illustrates and describes the details of construction.

CAR HEATING.—The perfected thermo-jet system of car heating is very fully described in a catalog being issued by the Safety Car Heating & Lighting Company, 2 Rector St., New York. This company has been most successful in the introduction of this system, which combines a steam and air system below 212 degs. temperature; a vapor system at 212 degs., and a pressure system above 212 degs.

THE PRODUCTS OF KENNICOTT.—A very attractive catalogue, arranged in loose leaf form for future additions that will be issued in the shape of bulletins, has been received from The Kennicott Co., Chicago. It briefly describes the plant, located at Chicago Heights, where this company manufactures its varied line of products, and includes illustrations and descriptions of the Kennicott water weigher that automatically and accurately weighs all water used by boilers or for other purposes.

PORTABLE ELECTRIC TOOLS.—Electric chipping hammers, drills, portable grinders, etc., have been perfected to a point where their reliability and durability are beyond doubt. An attractive catalog which fully illustrates and describes tools of this character in many different sizes and designs is being issued by the Cincinnati Electric Tool Company, 650 Evans St., Cincinnati, O. They are adapted for either direct or alternating current and possess a surprising power when the weight is considered.

TURRET LATHES.—A catalogue which is noticeable for its artistic arrangement and appearance, even in these days of high-grade catalog work, has been received from the Gisholt Machine Company, Madison, Wis. It contains excellent illustrations and clearly expressed descriptive matter on turret lathes, both belt and motor driven. A number of pages are given up to illustrations of the great variety of parts which can be completely finished on these lathes. Several unusual operations are illustrated in detail by photographs.

TRACTIVE EFFORT TABLES.—The March *Bulletin* of the American Locomotive Company considers the tractive effort of simple locomotives and includes very complete tables that give the tractive effort under practically all combinations of steam pressure, wheel diameter and cylinder size. This bulletin is arranged to be self indexing, the tables being on folded insert sheets. It, we believe, contains the only tables of tractive effort that cover large modern locomotives. Tables of piston speeds, speed factor, curves, cylinder volumes, weight of tubes, etc., are included.

DIRECT CURRENT MOTORS.—Bulletin No. 119, from the Fort Wayne Electric Works, Fort Wayne, Ind., briefly considers the Northern type B direct current motors, that are specially adapted for application to machine tools.

GLYCO METAL.—An 80-page, thoroughly illustrated booklet, that should be in the hands of every user of bearing metal, is being issued by Joseph T. Ryerson & Son, Chicago. Part of the book is given up to a discussion of the invention, function, properties, manufacture and application of Glyco metal; following which there is given the data on its performance in actual practice and tests, and description of the various grades. At the end of the book there are about twenty pages of the most valuable and interesting information on such subjects as the laws of friction; physical characteristics of lubricants; crank pin calculations; length of shaft bearings; specific gravity of an alloy; melting point of various substances, and admissible loads on bearings.

NOTES

BROWN HOISTING MACHINERY CO.—Fayette Brown, president, died on January 20. Mr. Brown was 87 years of age.

S. OBERMAYER CO.—Harry Hoover, a former well known foundry foreman, has been appointed the agent of this company in Buffalo and Dunkirk, N. Y.

ROBINS CONVEYOR BELT CO.—The executive, sales, engineering and purchasing departments of this company have been installed on the 26th and 27th floors of the Park Row building, New York. The branch office at 30 Church street will be discontinued.

WALTER B. SNOW, publicity engineer, announces that his office facilities have been more than doubled by removal to rooms 421 to 425, inclusive, 170 Summer street, Boston, Mass. Benjamin Baker, formerly of the Boston *Transcript*, and Herbert M. Wilcox, chemical engineer, have been added to his staff.

JOHNS-MANVILLE CO.—Both the Chicago and Baltimore branches of this company have outgrown their quarters and on March 1 the Chicago branch moved to 27 Michigan avenue, in the block between S. Water and River streets, where 32,500 square feet of floor space is available. The Baltimore office is now located at 30 Light street, where much larger quarters have been obtained. Both offices will keep on hand a large stock of J-M products and will be in a better position than ever to give prompt shipments.

KELLER MFG CO.—At the annual meeting of the Board of Directors in Philadelphia, the following officers were elected: Julius Keller, president; W. P. Pressinger, William H. Keller and S. W. Prince, vice-presidents; Frances J. Rue, treasurer, and C. S. Bell, secretary. This company has purchased the business of the W. P. Pressinger Company, of New York, and J. J. Swan, secretary of that company will now be associated with the Keller Co. It is also announced that Charles Strader has been placed in charge of the western branch, with offices in Chicago and Lincoln, Neb.

CHARLES F. AARON, general sales manager of the New York Leather Belting Company, died at his country home, Plainfield, N. J., on March 4. Mr. Aaron was probably the best known belting salesman in the United States for many years. He has been very prominent in various American machinery manufacturers associations and was president of the American Supply and Machinery Association. He has for a long time been waging a campaign, both personally and in this association, for raising to a higher plane the standards of manufacture of leather belting, and has had remarkable success in this direction. He was but 43 years old at the time of his death.

AN EFFICIENT FUEL DEPARTMENT.

A DESCRIPTION OF THE ORGANIZATION, METHODS OF ACCOUNTING AND OPERATION OF THE FUEL DEPARTMENT OF THE ATCHISON, TOPEKA & SANTA FE RAILWAY, WHICH HAS SHOWN REMARKABLE RESULTS NOT ONLY IN THE REDUCTION IN THE FUEL CONSUMPTION, BUT ALSO INDIRECTLY IN IMPROVING THE CONDITION OF THE MOTIVE POWER.

On the Atchison, Topeka & Santa Fe Railway System the locomotive and other fuel, from the time it is delivered by the mining comany to the time it is loaded on to the locomotive tenders, or put into the various coal bins, with the exception of the time it is actually in transit, is under the control of the general storekeeper, who handles it through a specially organized fuel department. The same thing applies to fuel oil, which is very extensively used on this road, and the features and forms explained in this article as applying to coal are also arranged to apply in exactly the same manner to fuel oil.

The organization of the fuel department is very simple and consists of a chief fuel supervisor, whose office is located adjacent to the general storekeeper at Topeka; a number of fuel inspectors, who are continually traveling over the system under the direction of the fuel supervisor; the foremen at the various fueling stations, who report direct to the supervisor, and the inspectors at the various mines, who inspect the coal delivered and weigh the cars. In addition there are several clerks and stenographers in the supervisor's office for maintaining the records, etc.

It is largely due to the system of accounting that the excellent results obtained have been possible. The forms used are such as will give accurate and detailed information concerning the fuel received at each station, the amount delivered to each locomotive, the time it was delivered, the length of time this locomotive was on the road, the tonnage hauled, the weather conditions and the name of the engineer and fireman. These reports are received daily and permit the immediate discovery of any unusual fuel consumption resulting in the immediate investigation of the reasons leading to it and the correction of the fault.

Starting at the mine—The coal is contracted for by the purchasing agent and is loaded and weighed under the supervision of one of the fuel department inspectors, who has the authority to refuse it unless the coal, in his opinion, is of the proper quality. These cars are then delivered to the station agent at this point, who fills in form 1281 in triplicate, one copy being sent to the mine as a receipt, the second to the fuel supervisor for his records and the third to the purchasing agent, who immediately pays the mining company for the coal upon the basis of this invoice.

The coal is then in what is known as "Stock A" and is held as an asset by the fuel department. The cars are forwarded by the station agent at the mine in accordance with the direction of the division superintendents, each mine furnishing certain particular divisions. The superintendents of these divisions each day notify this agent of the amount of coal they will require on the following day.

Form 1281, as will be seen by reference to the illustration, contains the way-bill number, the car initial and number, its destination, weight in pounds, and kind of coal. The last two columns of the form are not filled in by the forwarding agent but are completed in the supervisor's office from the information that is furnished by form 1284 which acts as a check in accounting for all cars that were reported as sent out from the mines.

At all fueling stations the foremen fill out and mail daily a copy of form 1284. This is made in duplicate, the copy being retained. As will be seen by reference to the illustration, this form contains the way-bill number and date on which each car was received, and must check with the same information on form 1281. The complete instructions on the back of this form explain its use clearly and are as follows:

Form 1281 Standard.

Santa Fe.

(Insert name of Railway Company.)

DAILY REPORT OF COMPANY "STOCK A" COAL FORWARDED

From _____ Station _____ 190__

WAY-BILL		DESTINATION	CAR		WEIGHT IN LBS.	Kind of Coal	INVOICE NO.	REPORTED BY	
No.	Date		Initial	Number				Station	Date

FORM 1281 IS FILLED IN BY THE AGENT AT THE SHIPPING POINT, A COPY BEING FORWARDED TO THE PURCHASING AGENT, FUEL SUPERVISOR, AND THE MINING COMPANY. THE PURCHASING AGENT PAYS FOR THE COAL AT ONCE ON THE BASIS OF THIS REPORT.

1. A report on this form must be rendered daily by Agents or Fuel Foremen at Fuel Stations as follows:

On A. T. & S. F. Ry., Coast Lines, Original of Front Page to Auditor and carbon copy of Front Page and Original of Back Page to Fuel Supervisor.

On G. C. & S. F. Ry., Original of Front Page to Auditor and carbon copy of Front Page and Original of Back Page to Fuel Supervisor.

On A. T. & S. F. Ry., only one copy to be made, which must be mailed to Chief Fuel Supervisor daily.

The copy of report for Fuel Supervisors to be made complete on one sheet. No carbon copy need be made of back page.

2. All fuel unloaded and used at station must be reported as received and unloaded on this form, giving complete way-bill reference. The billed weights shown on way-bills should in all cases be used; scale weights on coal from mine to be ignored.

3. Cars of fuel received at stations and held for disposition, are not to be reported on this form until unloaded or rebilled to other than regular Fuel Stations. When diverted to regular Fuel Stations, they must move under original way-bills, which are not to be taken into account until fuel reaches final destination and is unloaded. When forwarded to other than regular Fuel Stations, cars should be reported on this form and weights shown in column "For other purposes," way-bill taken into account and new billing issued and reference shown in column "Coal forwarded."

4. Stations at which there are no chutes will have to report coal received for locomotive purposes in No. 2 "Chutes" column.

Form 1284 Standard.

Santa Fe.

DAILY FUEL REPORT *from* _____ *Station.* *For* _____ *190*__

SEE COMPLETE INSTRUCTIONS ON BACK OF THIS FORM.

DEBITS

COAL RECEIVED AND UNLOADED

WAY-BILL NUMBER	WAY-BILL DATE	FROM	CAR NUMBER	(1) LBS. IN CHUTES FROM MINES	(2) Lbs. in Chutes from other Stations and from Storage	(3) LBS. UNLOADED IN STORAGE	(4) POUNDS FOR OTHER PURPOSES	WOOD RECEIVED CORDS

Form 814 Standard

Santa Fe.

(Insert name of Railway.)

Division.

DAILY TRAIN TALLY SHEET, AND TRAIN DISPATCHER'S REPORT OF TRAIN TONNAGE AND FUEL CONSUMPTION PER 100 TONS MILES IN _____ SERVICE. DATE _____ 19__

Train No.	Kind Train	CONDUCTOR	ENGINEER (Initials and name in full)	FIREMAN (Initials and name in full)	Engine No.	From	To	Actual Train Miles	Time Called	Time Left	Time Arrived	Total Time in Service Hrs.	Total Time in Service Min.	No. of Stops	TONNAGE LEAVING						NOT TO BE FILLED IN BY TRAIN DISPATCHER Ton Miles	Coal or Oil Consumed	Average Tons per Train	Average Pounds of Coal or Oil per 100 Ton Miles	REMARKS If Light Engine show reason for running, etc.

NOTE. { Be very careful to enter but one engine on a line.
Be very careful to show run of each engine outside of yard limits, including double-headers, helping and light engines, and engines doubling hills (both up and down).
Be careful to enter correct number of loaded and empty cars, and tons of freight in each train.
When work train runs some distance and then works between two points, be careful to show movement running and movement working, separately, giving time starting and stopping in each item.

This sheet to be made up in manifold in Train Dispatcher's office daily, and forwarded without delay as follows:

For The A. T. & S. F. Ry. to { Ticket Auditor, Topeka. Car Accountant, Topeka. Superintendent Transportation, Topeka.
" G. C. & S. F. Ry. to { General Supt., Galveston. Auditor, Galveston.
" A. T. & S. F. Ry., Coast Lines, to { Division Fuel Supervisor, Cleburne. Car Accountant, Los Angeles.
" E. Ry. of N. M. System and S. K. Ry. Co. of Tex., to { Auditor, Los Angeles. Division Fuel Supervisor, San Bernardino. Auditor, Amarillo.

Conductors are instructed to date their Train reports the day on which the train leaves, and the object of this sheet being to correct Conductor's reports, it is important that all TRAINS leaving Division stations before 12 o'clock, midnight, should be included.

. In giving time when trains leave and arrive, be careful to say whether it is "A. M." or "P. M." as in tracing cars of time freight it is necessary to know the exact time of arrival and departure of trains.

Construction and work trains are to be included in this sheet, showing between what stations they are at work.

All light engines must be shown, and in column of "Remarks" reason for movement entered, as "To even power," "Pusher returning to proper position," etc.

Reason for any unusual delays to trains must also be shown.

Make separate report for passenger and freight service.

Weather Conditions _____ Chief Train Dispatcher.

Form 814 9-09 25M 14720

M&AC0 10-09-3M-13201

FORM 814 IS USED BY THE DISPATCHERS THROUGHOUT THE SYSTEM. THE LAST FIVE COLUMNS ARE FILLED IN BY THE FUEL DEPARTMENT. A COPY OF THIS SHEET IS RECEIVED DAILY FROM EVERY TERMINAL ON THE SYSTEM.

5. Special debit must be taken in proper column for all chute droppings picked up at station.

6. When storage coal is picked up and unloaded in chutes, the car number must be shown and pounds thus transferred reported in "Chutes" column in black ink, and credit allowed opposite in "Storage" column in red ink. When storage coal is forwarded to other stations, credit allowed should be in "Storage" column in red ink.

7. Column "Pounds for other purposes" is to be used for reporting coal received and used for other than locomotives and such as is forwarded to other than regular Fuel Stations.

8. Fuel tickets must be obtained for all issues of coal and wood to locomotives; these are to be listed on back of this report in space provided, and balance with total issues to locomotives shown on face of report for which credit is taken. Fuel furnished to helper and light locomotives should be charged to class of service assigned; fuel for locomotives in Work Service to be charged to "Freight."

Fuel furnished locomotives at end of trip must always be charged to the class af service just completed.

When no ticket is obtained, the issue should nevertheless be charged to the engineman and locomotive taking the coal.

9. Slack coal from mine for stationary engines must not be reported on this form or shown as issued. Nor other coal which is consigned to and used by the Mechanical Department.

Form 1284 is sent in daily to the fuel supervisor and is accompanied by the fuel tickets on form 1120 (see illustration). These tickets are listed in the spaces on the back of 1284, which table forms the complete report of the amount of coal issued each day at each station, the name of the engineer and fireman who brought the locomotive in, the engine number and the class of service in which it was used. On the face of the form are recorded the coal issued for other purposes. In this manner a complete daily balance showing the condition in each station is obtained.

When a locomotive is put into service its tender is filled with coal, and from that time on whatever coal is required to again fill the tender is charged to the service in which the locomotive has been engaged. For instanc, if a locomotive is fired up in the roundhouse and held for some time, using considerable coal, when it starts out to take a train the tender is filled and the amount taken is charged to roundhouse use. In fact, in every case a locomotive starting from the terminal with a train has a full tender, the amount required to fill it being charged to roundhouse use, inasmuch as it went into the house with a full tender. At the end of the run it again goes to the coal chute and the engineer delivers to the fuel foreman a copy of form 1130, which gives the record of the engine and train number, the service in which it has been engaged and the amount of coal the engineer *estimates* will be required to fill the tender. This is signed with the engineer's and fireman's name, and while it is not forwarded to headquarters, it is kept by the fuel foreman as a check.

After the coal is actually delivered to the locomotive and the amount is accurately known, form 1120, which is in triplicate and arranged to fold in such a way as to permit the use of carbon paper for making all three copies at one time, is filled out by the fuel foreman. This contains in addition to the information contained on form 1130, the actual amount of coal taken and the fuel foreman's signature. One copy of this form is forwarded daily with form 1284, previously mentioned, one copy is given to the engineer and the third copy is retained by the fuel foreman.

Form 1120 is made in four colors, the white being for locomotives in freight service; the red for passenger service; the yellow for switching service and the blue for mixed or work train service.

Form 1120 Standard
Santa Fe.
COAL TICKET FOR FREIGHT SERVICE ONLY
№ 92301

Station ..... 19....
Initials ..... Eng. No. .....
Train No. ..... Time Issued ..... M.
From ..... To .....
Pounds taken .....

Engineer.
Fireman.
Fuel Foreman.

Mail 10 00 1 M Blks 15512

Form 1120 Standard
Santa Fe.
COAL TICKET FOR FREIGHT SERVICE ONLY
№ 92301

Station ..... 19....
Initials ..... Eng. No. .....
Train No. ..... Time Issued ..... M.
From ..... To .....
Pounds taken .....

Engineer.
Fireman.
Fuel Foreman.

FORM 1120 IS FILLED IN BY THE FUEL FOREMAN WHENEVER A LOCOMOTIVE TAKES COAL. THE BLANK SPACE IN THE CENTRE IS A DUPLICATE OF THE OTHER FORMS, BEING PRINTED ON THE BACK OF THE SHEET, SO THAT WHEN FOLDED TWO CARBON PAPERS WILL MAKE THREE COPIES. ONE COPY IS SENT TO THE FUEL DEPARTMENT HEADQUARTERS DAILY WITH FORM 1284, ONE IS DELIVERED TO THE ENGINEMAN AS A RECEIPT, AND THE THIRD IS RETAINED FOR A RECORD.

* IF EXTRA, SHOW DIRECTION, EAST WEST NORTH OR SOUTH.

LIST OF ENGINE TICKETS FOR COAL AND WOOD FURNISHED.

ENGINEER	FIREMAN	*Train No.	COAL IN POUNDS—CLASS OF SERVICE					WOOD IN 16ths—CLASS OF SERVICE			
			Engine No.	PASSENG'R	FREIGHT	MIXED	SWITCH	PASS.	FREIGHT	MIXED	SWITCH
TOTAL,											

BACK OF FORM 1284 SHOWING THE ARRANGEMENT FOR LISTING THE COAL ISSUED AT EACH STATION. THIS INFORMATION IS COPIED FROM FORM 1120, WHICH ARE SENT IN DAILY WITH THIS REPORT. THE FACE OF THE FORM IS SHOWN IN ONE OF THE OTHER ILLUSTRATIONS.

Santa Fe.

Record of ____ ____ Received and Issued at ____ ____ During Month of ____ 191

Date	RECEIVED				ISSUED																		
	Received from Mines	Chute Droppings	Transferred From Other Fuel Stations	Total on Hand and Received	6 Section Hs's Pits Dr Trk.	9 Pits Dr.-Reg. Reg With Hs.	Shop Expense Weight	Stationary Eng's Car Number		81 Roundhouses	LOCOMOTIVES 82 Passenger	83 Freight	84 Mixed	73 Switch	63 Water Supply	85 Small Houses	89 Cars, P-Nos. P-Ft.	60 Stations Pas.-Ft. Coal	66 Rating Hs's 30 B.C. Rms.	Sold	Transferred to	TOTAL	Date
On Hand 1 day of Month																							
1																							1
2																							2
3																							3
4																							4
5																							5
6																							6
7																							7
28																							28
29																							29
30																							30
31																							31
Totals																							
On Hand 32nd of Month																							
On Hand last inventory																							
Inventory Date of Hand																							

FORM 1135 IS MAINTAINED IN THE FUEL DEPARTMENT OFFICE, BEING FILLED IN FROM THE REPORT ON FORM 1284. THE FIGURES AT THE HEAD OF EACH ITEM REFER TO THE INTERSTATE COMMERCE COMMISS ION CLASSIFICATION.

Form 533 Standard

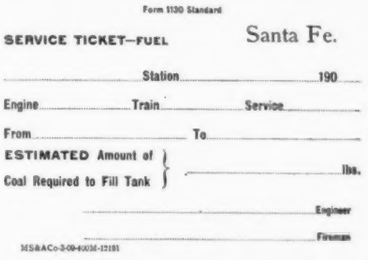
Santa Fe.

Summary of COAL OR WOOD Account by Fuel Stations, Month of

STATION	Inventory Date	RECEIVED			TOTAL	ISSUED					SOLD	Forwarded to Other Stations	TOTAL	Book Balance	Inventory Date	SHORTAGE	OVERAGE
		Purchased	From Other Stations	Chute Droppings or Old Ties		To Locomotives				Miscellaneous							
						Passenger	Freight	Mixed	Switch								

FORM 533 WHICH GIVES A MONTHLY SUMMARY OF ACCOUNTS FOR EACH OF THE FUEL STATIONS. IT IS FILLED IN FROM THE REPORTS ON FORM 1135 AND PERMITS THE CONDITION OF THE WHOLE SYSTEM T O BE EVIDENT AT A GLANCE.

The most important feature of this system is the daily train tally sheet, form 814, which is the supporting base on which the system is founded. From it is compiled the various reports carrying information that has assisted so materially in reducing the consumption of fuel. This form is simply an enlargement of the ordinary tally sheet in use by practically all railroads. As originally printed, it was made in the trainmaster's office from the train sheets and copies sent to the ticket auditor, car accountant, superintendent and master mechanic, and as printed to-day it is compiled as formerly by the trainmaster; additional information in way of tonnage handled in trains between stations being entered by that office and an extra copy to that formerly sent to the superintendent and master mechanic, being sent to the fuel department. On receipt the fuel department inserts the ton-miles as well as the pounds of fuel consumed by each engine and crew and the average train haul, also the consumption of fuel per 100 ton-miles. Each trip is closely observed and excess consumption noted, and in returning the form to the superintendent his attention is called to all excessive consumption of fuel


Form 1130 Standard

SERVICE TICKET—FUEL Santa Fe.

Station 190

Engine Train Service

From To

ESTIMATED Amount of Coal Required to Fill Tank lbs.

Engineer

Fireman

MS&ACo-3-09-M3M-12181

FORM 1130 IS FILLED IN, SIGNED AND DELIVERED TO THE FUEL FOREMAN BY THE LOCOMOTIVE ENGINEER WHEN HE ARRIVES AT THE COALING STATION AND DESIRES TO TAKE ON COAL.

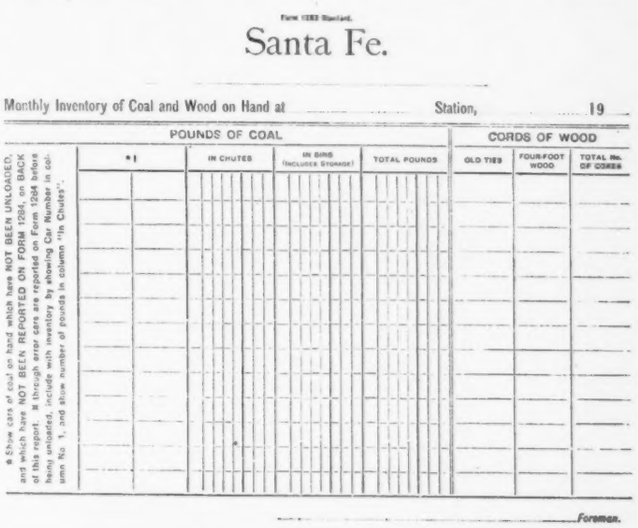
caused by delays in getting over the road, while in sending the form to the master mechanic, if the fault is with the crew or from apparent difficulties in the engine, his attention is called to it by a special letter. These reports are compiled in the fuel office and sent out not later than five days after the trip is completed

This tally sheet acts as a check on 1284, and if any train is shown on the dispatcher's sheet and no corresponding record appears on the fuel foreman's report, it immediately shows that there has been a mistake made or the presence of laxness at this point. It is also possible from this sheet to immediately check up any unusual fuel consumption in any service and in fact it permits the immediate location of any error or unusual circumstance anywhere on the system.

Form 1135 is kept in the fuel supervisor's office, there being one sheet for each coaling station, and is arranged to form a monthly record of that station. It is filled in from form 1284 daily and gives the receipts and issues of each station in detail. The numbers appearing in the different columns refer to the Interstate Commerce Commission classification. It will be noted that at the bottom of the sheet are headings showing the amount of coal on hand at the end of the month, as indicated by the totals on the sheet and the heading "On Hand Per Inventory." This inventory is made monthly on form 1283 (see illustration), which will explain itself. It is very carefully filled out by the fuel foreman and the amounts will probably differ somewhat from those shown by the totals on form 1135, due to shrinkage, chute droppings, errors in estimates, weighing, etc. It, however, is entered on 1135, and the difference in the amount shown by the inventory and the amount shown by the record of the month is entered in the proper column. This difference is corrected monthly by a readjustment of the price, never by the amount of coal on hand. Form 1135 for the next month's service is started with the amount of coal on hand as shown by the inventory and no attempt is made to alter these figures to take care of the errors in the report; these differences, as just stated, being taken care of in the price charged the motive power department for the coal.

The chute droppings are periodically picked up and loaded upon a car and are received by the coaling station the same as coal coming from the mine. They are never simply returned to the bins and counted as profit. Thus the total amount of coal which leaves the chute is charged up to the engine being coaled, which influences the engine crew to be very careful not to overload their tenders, or to allow coal to fall upon the ground.

Form 533 is filled in from the totals of 1135 and gives a monthly report of the whole system. It will be seen that the informa-


Form 1283 Standard.

Santa Fe.

Monthly Inventory of Coal and Wood on Hand at ..... Station, ... 19 ...

	POUNDS OF COAL				CORDS OF WOOD		
* Show cars of coal on hand which have NOT BEEN UNLOADED, and which have NOT BEEN REPORTED ON FORM 1284, on BACK of this report. If through error cars are reported on Form 1284 before being unloaded, include with inventory by showing Car Number in column No. 1, and show number of pounds in column "In Chutes".	* 1	IN CHUTES	IN BINS (INCLUDES STORAGE)	TOTAL POUNDS	OLD TIES	FOUR-FOOT WOOD	TOTAL No. OF CORDS

Foreman.

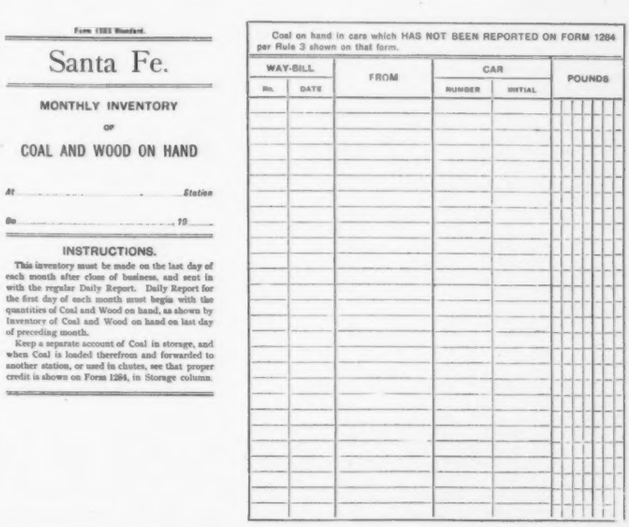
THE FACE OF FORM 1283 ON WHICH THE MONTHLY INVENTORY, AT EACH FUELING STATION, IS MADE. THE BACK OF THIS FORM IS SHOWN IN ANOTHER ILLUSTRATION.

tion on this is practically the same as that on the monthly balance sheet of the department for the whole system and the original is sent to the auditor, a copy to the vice-president in charge of purchases, and a copy is retained.

The distribution of the fuel which is shown on form 564 is made up from forms 533 and 1135, and is furnished monthly for the information of the auditing department and is used for charging out from "Stock A" fuel accounts direct to the different operating accounts.

Form 1132 is compiled from form 814, which process consists of segregating the various engineers, firemen and engines on individual sheets according to the various classes of engines, etc., thus enabling the department to obtain the individual performance of each.

Form 1133A is filled in from 1132, and includes columns for


Form 1283 Standard.

Santa Fe.

MONTHLY INVENTORY

OF

COAL AND WOOD ON HAND

At ..... Station

On ..... 19 ...

INSTRUCTIONS.

This inventory must be made on the last day of each month after close of business, and sent in with the regular Daily Report. Daily Report for the first day of each month must begin with the quantities of Coal and Wood on hand, as shown by Inventory of Coal and Wood on hand on last day of preceding month.

Keep a separate account of Coal in storage, and when Coal is loaded therefrom and forwarded to another station, or used in chutes, see that proper credit is shown on Form 1284, in Storage column.

Coal on hand in cars which HAS NOT BEEN REPORTED ON FORM 1284 per Rule 3 shown on that form.

WAY-BILL		FROM	CAR		POUNDS
No.	DATE		NUMBER	INITIAL	

BACK OF FORM 1283 SHOWING THE INSTRUCTIONS FOR MAKING THE MONTHLY INVENTORY AND CONTAINING SPACE FOR REPORTING THE CARS WHICH HAVE ARRIVED AT THE COALING STATION BUT HAVE NOT YET BEEN UNLOADED AND HENCE NOT YET REPORTED ON FORM 1284. THE FACE OF THE FORM IS SHOWN IN ONE OF THE OTHER ILLUSTRATIONS.

Santa Fe.

(Insert name of Railway Company.)

_____ Division, _____ Line.
(Insert "Main" or "Branch.")

DISTRIBUTION OF FUEL *for Month of* _____ 190__

ACCOUNTS	ISSUED TO	COAL TONS	WOOD CORDS	FUEL OIL TONS	AMOUNT COAL AND OIL	AMOUNT WOOD
6	Pile Drivers, etc.,					
9	" "					
9	Bridge Watch Houses,					
61	Superintendents' Offices,					
66	Stations, Freight,					
	" Passenger,					
	" Common,					
66	Eating Houses,					
70	Yard Offices,					
78	Locomotives, Yard,					
82	" Road,					
88	Water Supply,					
89	Fuel for Cars, Freight,					
	" " Passenger,					
	" " Common,					
89	Reading Rooms,					
93	Clearing Wrecks, Freight,					
	" " Passenger,					
	" " Common,					
108	General Offices,					
"Operations of Gravel Pits"	Location:					
"Shop Expenses"						
"Treating Plants"	Location:					
	TOTAL ISSUED,					
	Disbursements Recollectible (As per Statement Attached),					
	TOTAL ISSUED AND SOLD,					

This distribution must be accompanied by a schedule of the bills made to cover the charge to "Disbursements Recollectible," giving the amount of each, and against whom rendered.

_____ 190 _____

FORM 564, ON WHICH IS SHOWN THE MONTHLY DISTRIBUTION OF THE FUEL IN ANY PARTICULAR STATION. THIS IS FILLED IN FROM THE INFORMATION ON FORMS 533 AND 1135. THE ORIGINAL OF THIS FORM IS FORWARDED TO THE AUDITOR AND A COPY IS RETAINED IN THE FUEL DEPARTMENT OFFICE.

Hall 4-10-10M 1907

Santa Fe.

_____ DISTRICT. _____ DIVISION.

Engineer_____ _____ 19__

Date	TRAIN No.	FIREMAN	ENGINE No.	STATION From	STATION To	TRAIN MILES East	TRAIN MILES West	TOTAL TIME Hrs.	TOTAL TIME Min.	No. of Stops	TON MILES East	TON MILES West	COAL OR OIL CONSUMED	REMARKS

FORM 1132 WHICH IS FILLED IN FROM THE DISPATCHER'S TALLY SHEET AFTER IT HAS BEEN COMPLETED IN THE FUEL SUPERVISOR'S OFFICE. IT GIVES THE INDIVIDUAL PERFORMANCE OF ANY ENGINEER OR FIREMAN, AND CAN ALSO BE USED FOR ANY INDIVIDUAL LOCOMOTIVE. THESE COPIES ARE USUALLY FOR THE FUEL DEPARTMENT INFORMATION ONLY.

[Form 1133-A Standard]

Santa Fe.

(Insert Name of Railway Company)

FUEL PERFORMANCE OF_____

_____DIVISION MONTH OF_____19__

	TOTAL ENGINE MILES	TOTAL TON MILES	POUNDS OF COAL OR OIL CONSUMED	AVERAGE POUNDS OF COAL OR OIL PER 100 TON MILES	AVERAGE TONS HAULED PER TRAIN	ACTUAL COST OF FUEL CONSUMED	COST OF FUEL BASED ON DIVISION AVERAGE	TOTAL MONEY LOSS OR GAIN BASED UPON AVERAGE COST PER TON MILE	
								LOSS	GAIN

FORM 1133A. THE INFORMATION IS FILLED IN FROM FORM 1132 AND THE ITEMS CONCERNING COST ARE COMPUTED AND INSERTED. THIS FORM IS FOR FUEL DEPARTMENT INFORMATION ONLY, BUT IS VERY LARGELY TRANSFERRED TO FORM 1133, WHICH IS SHOWN IN ONE OF THE OTHER ILLUSTRATIONS

the money value of the fuel consumed by the locomotives under the charge of each engineer. The column headed "Actual Cost of Fuel Consumed" is the product of the number of tons actually used by this engineer and the average monthly cost for that station. This cost being the price charged by the fuel department to the motive power department, and includes all of the cost of handling as well as the expenses of the fuel department. The next column headed "Cost of Fuel Based on Division Average" is the same value per ton multiplied by the average number of tons used by the locomotives on this division engaged in the same service, the ton mileage being the basis. The following two columns then show the loss or gain of this engineer as compared with the average.

Form 1136 Standard.

Santa Fe.

Comparative Statement Showing the Tonnage and Fuel Consumption Each Day on Train

No.___ ___ ___between____ ____ ____ ____ and____ ____ ____ ____ ____ ____ ____ ____Division, Month of____ ____ ___190__

DATE	ENGINEER	ENGINE No.	ACTUAL TRAIN MILES	TOTAL TIME IN SERVICE	TON MILES	POUNDS OF FUEL CONSUMED	AVERAGE TONS PER TRAIN	AVERAGE LBS. OF FUEL PER 100 TON MILES
1								
2								
3								
4								
28								
29								
30								
31								
Total								

FORM 1136 ON WHICH A MONTHLY RECORD OF ANY PARTICULAR TRAIN CAN BE RECORDED.

Form 1133 Standard.

Santa Fe.

(Insert name of Railway Company.)

FUEL PERFORMANCE OF ENGINES, ENGINEERS OR FIREMEN.

_____DIVISION MONTH OF_____19__

	TOTAL ENGINE MILES	TOTAL TON MILES	POUNDS OF COAL OR OIL CONSUMED	AVERAGE POUNDS OF COAL OR OIL PER 100 TON MILES	AVERAGE TONS HAULED PER TRAIN	TOTAL MONEY LOSS OR GAIN DUE TO PERFORMANCE SHOWN, BASED UPON AVERAGE COST PER TON MILE	
						LOSS	GAIN

[redacted] [redacted] _____

Superintendent. Div. Master Mechanic. Fuel Supervisor.

Date_____

FORM 1133, WHICH IS PRINTED ON OILED PAPER. THE ITEMS ARE TRANSFERRED FROM 1133A AND FROM THIS ARE MADE BLUE PRINTS THAT ARE SENT TO ALL INTERESTED AND ALSO POSTED ON BULLETIN BOARDS AT THE LOCOMOTIVE TERMINALS.

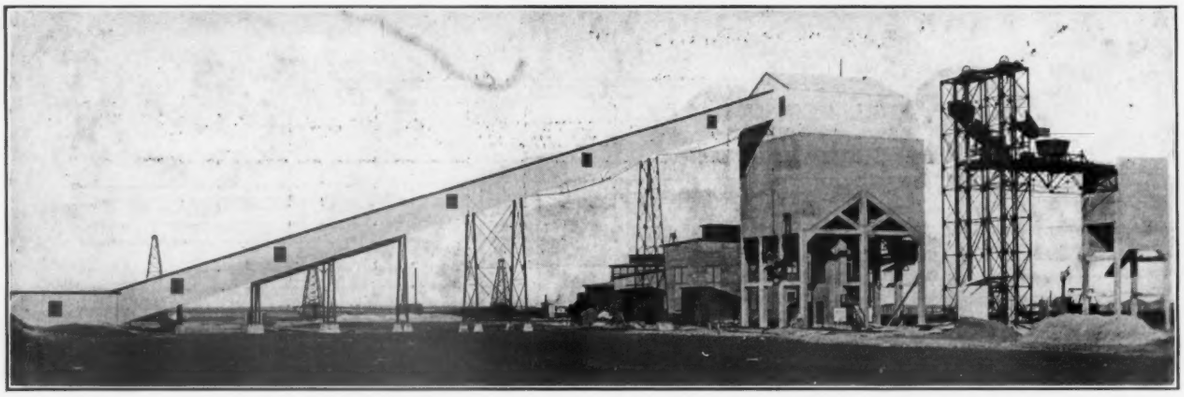
Next column headed "Cost of Fuel Based on Division Average" is the same value per ton multiplied by the average number of tons used by the locomotives on this division engaged in the same service, the ton mileage being the basis. The following two columns then show the loss or gain of this engineer as compared with the average.

Form 1133 contains the same headings as 1133A, with the exception of the actual cost of fuel consumed and the cost based on the division average, this sheet showing simply the loss and gain. It is printed on oiled paper and from it are made blue prints which are forwarded to all terminals where they are placed upon the bulletin board. Copies are sent to the superintendents of motive power, master mechanics, road foremen of engines and any one else concerned with the fuel record.

A form is also provided which will permit a comparative statement of the fuel consumption on any particular train during the month. This is numbered 1136 and is taken from the train dispatcher's tally sheet after it has been filled in by the fuel department.

COALING STATIONS.

It will be readily seen that the value of all these records and information concerning fuel consumption depends largely upon the accurate and prompt reporting of the amount of coal actually placed upon each locomotive. All of the old style so called "Trestle of Gravity Chutes" on the line were repaired and pockets calibrated according to the cubic contents of a ton of coal and great care exercised by fuel foreman to see that each issue was properly measured. It was quickly found, however, that what was required was a chute which would give within very narrow limits exactly the amount of coal put on each tender. This, of course, can best be done by actual weighing and it was decided by the management that all of the coal stations built in the future would be of the so-called "Mechanical Type." These chutes all have weighing hoppers which gives, by the balancing of a scale beam, exactly the amount of coal taken.



COALING STATION AND CINDER HANDLING PLANT ERECTED BY THE ROBERTS & SCHAEFER CO. AT CLOVIS, N. M. THIS IS OF REINFORCED CONCRETE AND STEEL CONSTRUCTION THROUGHOUT. THE COALING STATION USES A CONVEYOR BELT AND THE CINDER HANDLING PLANT A BALANCED BUCKET AND TRAM-CAR HANDLING ARRANGEMENT. THIS COALING STATION HAS A 750 TON CAPACITY STORAGE POCKET AND IS EQUIPPED WITH FOUR 6-TON WEIGHING HOPPERS.

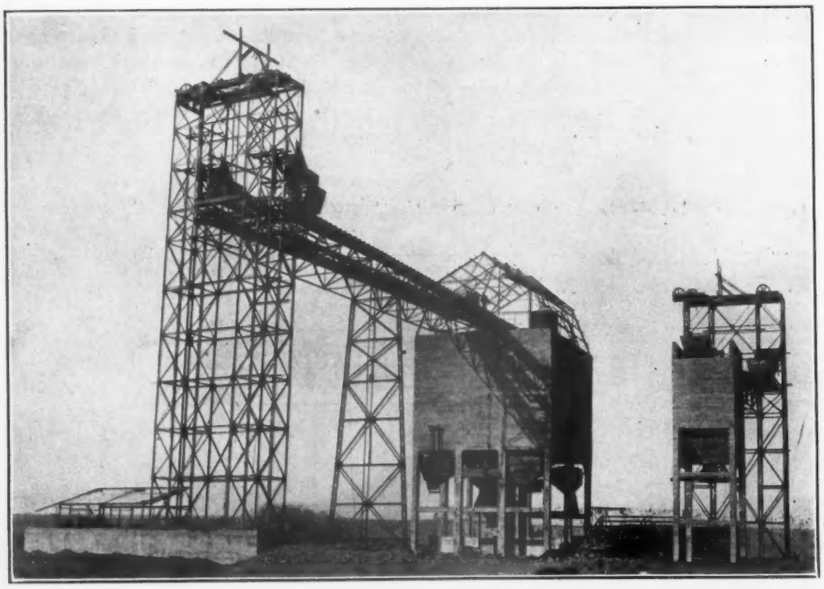
Practically all of the coal chutes of the weighing hopper type that have been installed in the past few years have been built by either the Roberts & Schaefer Co. or Fairbanks, Morse & Co. They are all of the mechanically operated design of different capacities and arrangements to suit the different conditions. The illustrations show the general appearance of a number of these coaling stations and a few typical examples will be briefly described.

At Clovis, N. M., a 750-ton capacity concrete and steel station, built by the Roberts & Schaefer Co., has been provided. This plant is of the belt conveyor type, the coal being placed in a receiving hopper 250 ft. away from the coal pocket. From this hopper it is delivered to the belt conveyor by a reciprocating feeder. The coal pocket itself is of reinforced concrete, with the exception of the monitor house, which is of steel covered with asbestos protected metal. The trestle for the belt conveyor is entirely of steel, with the exception of the housing for the belt, which is of wood covered with corrugated asbestos protected metal. The conveying apparatus is in duplicate and the station is arranged to coal four tracks. From the storage hopper the coal is delivered to four 6-ton weighing hoppers, two on each side, each having chutes arranged to serve two tracks. These weighing hoppers are connected to the scale beam, which is balanced before and after the locomotive takes its supply.

The plant is motor driven, the motor being placed at the head of the main conveyor in the monitor house. An auxiliary motor is provided on the trestle for bringing the coal up from the receiving hopper to the boiler house coal storage bin, located underneath it.

The same station encloses the sand equipment, the green sand being delivered by the belt conveyor to a storage bin near the top of the coal chute, from which it falls by gravity to a drier located at the ground level and after drying is elevated by air to another bin from which it is delivered to the locomotives by gravity.

In connection with this coaling station there is a cinder handling plant, consisting of a storage bin with a capacity of 146 cu. yds., built entirely of reinforced concrete, the cinders being delivered to it by an elevating system consisting of a pair of Holman balanced buckets and an automatic tram car system. The cinders are drawn from the locomotive into the cinder pits, there being two, one on each side of the receiving hopper, from which they are dumped into the buckets and then hoisted and delivered into the tram car system, which conveys them to the storage pocket. The operation of the whole apparatus is automatic.



A CONCRETE AND STEEL COALING STATION ERECTED BY ROBERTS & SCHAEFER CO. AT BELEN, N. M. IN THIS STATION THE COAL IS ELEVATED BY HOLMAN BALANCED BUCKETS AND TRANSFERRED BY A DOUBLE AUTOMATIC TRAM-CAR SYSTEM. BELOW THE STORAGE BIN ARE FOUR 6-TON AUXILIARY WEIGHING POCKETS, ARRANGED THE SAME AS AT CLOVIS. AT THE RIGHT IS SEEN A CINDER HANDLING PLANT OF THE SAME CONSTRUCTION AND ARRANGEMENT AS THE COALING STATION.

The photograph of this plant clearly shows both the coaling station and the cinder handling arrangement. The boiler house storage bin under the conveyor trestle had not been installed when the photograph was taken.

Another station built by the same company at Belen, N. M., is very similar to that of Clovis, with the exception of the method of conveying the coal from the receiving hopper to the storage.

In this case Holman balanced bucket elevators working in connection with an automatic tram car system, very similar to the cinder plant at Clovis, are used. The two elevating buckets are connected directly to a hoist placed between them and the cable is so wrapped around the drum that when one bucket is loading at the bottom the other is unloading at the top. The tram cars are also connected to the same hoist and are entirely automatic in their operation, one car being dumped into the pocket while the other is receiving its load at the hoist. This plant is entirely of

steel and reinforced concrete and therefore absolutely fireproof.

At Belen there is also a cinder handling plant of the same design and arrangement as at Clovis.

The same company also erected a 350-ton plant at Vaughn, N. M., constructed entirely of wood except the sand storage bin, which is of reinforced concrete. This plant is arranged similar to the one at Belen, using the Holman balanced bucket elevators in connection with an automatic tram car system. It is arranged to coal three tracks and has the 6-ton auxiliary scale hoppers the same as the other plants.

The four stations at Becker, Taivan, Willard and Yesso, N. M., that are practically identical in design were also constructed by the same company. The one at Becker has a 350-ton storage capacity, and the others 250-ton. The plants are of the simple Holman balanced bucket type, where the coal is received into a hopper at one side of the station and delivered by a pair of bal-

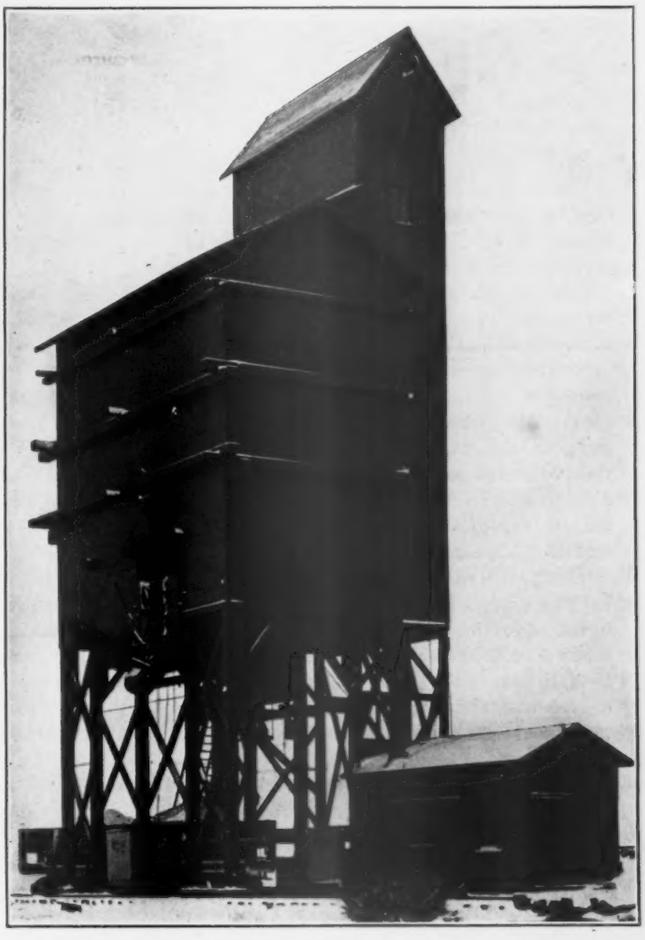
COALING STATION ERECTED BY ROBERTS & SCHAEFER CO., AT VAUGHN, N. M. IT IS OF TIMBER CONSTRUCTION AND USES HOLMAN BALANCED BUCKETS WITH AUTOMATIC TRAM CARS FOR FILLING THE STORAGE POCKETS. THE CONCRETE BUILDING IN THE CENTRE IS FOR SAND STORAGE.

anced buckets directly into the coal pocket above. They are entirely of wooden construction with concrete foundations and concrete receiving hoppers. The locomotives are coaled on two tracks, one beneath the pocket and one at the side. They have the same auxiliary weighing hoppers as the other plants mentioned above. The power for these four plants consist of a gasoline engine driving a reversible hoist.

Fairbanks, Morse & Co. have erected eleven coaling stations for the Santa Fe, which are arranged on two general systems, one having a coaling bridge spanning several tracks and the other arranged to coal on the two tracks alongside the building only.

One of the illustrations shows the station at Augusta, Kans., which is of the type having the bridge. This plant is arranged to coal four tracks, one on either side of the building and two beneath the bridge. The coal going to the locomotive tender is all handled through 10-ton suspension scale pockets, there being

300 TON COALING STATION ERECTED BY FAIRBANKS, MORSE & CO., AT AUGUSTA, KAN. THIS STATION IS TYPICAL OF THE LARGE NUMBER ERECTED BY THIS COMPANY FOR THE SANTA FE AND IS PROVIDED WITH 10-TON AUXILIARY SCALE POCKETS, WHICH PERMIT THE ACCURATE WEIGHING OF THE COAL PUT ON EACH LOCOMOTIVE TENDER. THIS STATION COALS FOUR TRACKS AND OTHERS OF THE SAME TYPE WITHOUT THE BRIDGE COAL TWO TRACKS

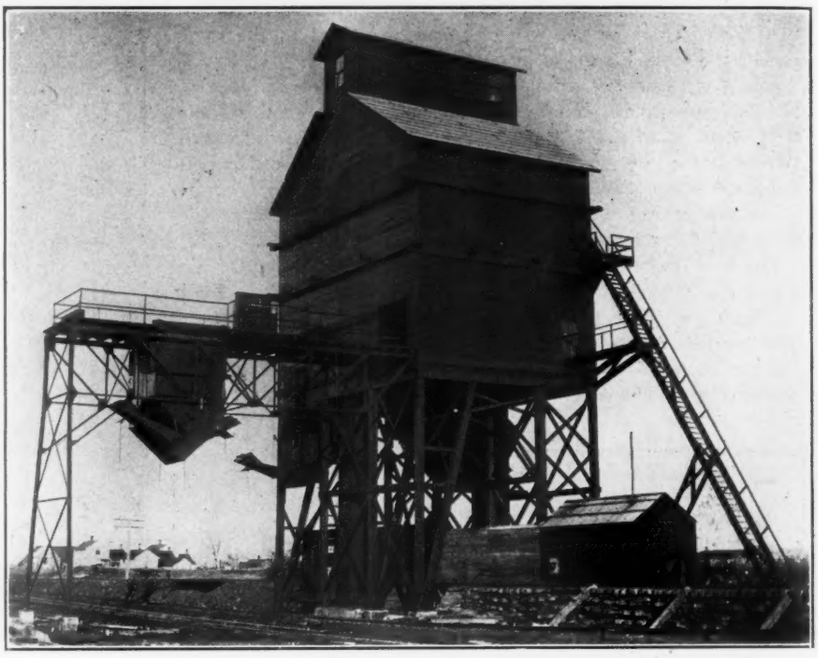


COALING STATION ERECTED AT BECKER, N. M., BY THE ROBERTS & SCHAEFER CO. THIS PLANT IS TYPICAL OF FOUR PLANTS CONSTRUCTED ON THE EASTERN RAILWAY OF MEXICO AND USES THE HOLMAN BALANCED BUCKETS FOR ELEVATING. THEY SERVE TWO TRACKS AND ARE PROVIDED WITH TWO 6-TON AUXILIARY WEIGHING HOPPERS.

one of these pockets on the bridge furnished with two outlet chutes.

All of the stations erected by this company are of the same general arrangement, and have a 300 net ton total capacity. The coal is discharged into the receiving hopper below the center of the station, and from there is conveyed by a continuous loader into the elevator boot and from this point elevated by means of a bucket conveyor to the storage bin above. The 10-ton scale pockets are filled from the storage bin by means of undercut gates operated from below. The power is furnished by a Fairbanks, Morse & Co. 15 h.p. horizontal gasolene engine and a car puller equipment, having a capacity to handle two loaded cars over the receiving hopper, is provided at each station. The handling capacity of all of these plants is 70 tons per hour.

At the stations provided with the coaling bridges the suspended 10-ton scale pocket on the bridge is filled by a two-ton side dump car, which receives its supply directly from the storage bin. The scales in this type of station are located on the bridge, but where no bridge is provided the scale beam is located on the ground. The beams read in 20 lb. increments and the amount of coal withdrawn from the pocket is automatically recorded on single or manifold tickets.



COALING STATION ERECTED BY THE ROBERTS & SCHAEFER CO. AT BARING, MO. THIS PLANT IS OF THE CHAIN AND BUCKET TYPE AND HAS A CAPACITY OF 500 TONS. THERE ARE TWO SUSPENDED WEIGHING POCKETS ON THE STATION PROPER, AND IN ADDITION THERE IS A STEEL BRIDGE WITH A 10-TON WEIGHING HOPPER FOR SERVING THE TWO MAIN LINE TRACKS. THIS HOPPER IS SERVED BY MEANS OF A 3-TON CAR, WHICH RECEIVES ITS LOAD FROM THE MAIN STORAGE POCKET. THE PLANT IS OF WOODEN CONSTRUCTION WITH THE EXCEPTION OF THE BRIDGE.

INTERNATIONAL RAILWAY FUEL ASSOCIATION

SECOND ANNUAL CONVENTION, LA SALLE HOTEL (18TH FLOOR), CHICAGO, MAY 23-26.

The hours of session will be from 9 A. M. to 1 P. M. on the four days, and the members will be welcomed on the opening day by the Mayor of Chicago and addresses are contemplated by other prominent men.

Members are particularly urged to bring their families to this convention. The hours of session were purposely arranged without intermission to permit of an opportunity for recreation and to establish a better acquaintance between the members. The matter of entertainment (entire expense of which will be borne by the Association) will be a distinct feature this year. Something will be doing every day in connection with complimentary theater parties to members and their friends, a trip across Lake Michigan and return on a commodious passenger steamer, or a visit to one of Chicago's large amusement parks; besides automobile rides, etc., are being arranged for.

The International Railway Fuel Association is the largest railway organization for its age ever in existence, and perhaps has attracted more attention in this country and Europe than any other association. The commodity "Fuel" is of more importance to railroads from a cost standpoint than anything else purchased, and with this live subject is it any wonder that all of our large and small railroads are interested as members in this association.

The list of subjects to be read and discussed is as follows:

PAPERS NOS. 1 AND 5 CONSOLIDATED.

"Grade of fuel most suitable for locomotive use, considering cost per unit of traffic and best interests of producer." "Recommended methods of preparing coal as to size for locomotives."

J. G. Crawford, Chairman, Fuel Engineer, C., B. & Q. R. R., Chicago.
LeGrand Parish, S. M. P., L. S. & M. S. Ry., Cleveland, Ohio.
Curtis Scovill, A. G. S. A., Central Coal & Coke Company, Dallas, Texas.

PAPER NO. 2.

"Standard uniform blank for reporting all items of cost in connection with fueling stations and handling fuel, for all types of stations and conditions."

R. Emerson, Chairman, Consulting Engineer, A., T. & S. F. Ry., Chicago, Ill.
F. V. Hetzel, Chief Engineer, Link Belt Co., Nicetown, Pa.
E. A. Averill, Editor, *American Engineer and Railroad Journal*, New York, N. Y.
N. M. Rice, G. S. K., A., T. & S. F. Ry., Topeka, Kansas.

PAPER NO. 3.

"Accounting for fuel consumed; individual records of performances."

W. E. Symons, Chairman, C. & G. W. Ry., Chicago.
E. A. Foos, C. C. Fuel, Rail and Tie Dept., C., B. & Q. R. R., Chicago.
E. J. Roth, Jr., Fuel Inspector, B. & O. R. R., Baltimore, Md.

PAPER NO. 4.

"Methods of purchasing fuel with regard both to traffic conditions and to producers' interests. Relation between producer and railroad."

W. H. Huff, Chairman, V. P., Victor-American Fuel Co., Denver, Colo.
L. L. Chipman, G. S. M., Fidelity Coal Mining Co., Kansas City, Mo.
W. K. Kilgore, Fuel Agent, C., M. & St. P. Ry., Chicago.

PAPER NO. 6.

"Methods of supervision, instruction and encouragement in locomotive operation to secure greatest efficiency in fuel consumption."

D. Meadows, Chairman, Asst. Div. M. M., Michigan Central R. R., St. Thomas, Ont.
W. C. Hayes, Supt. Locomotive Operation, Erie R. R., New York, N. Y.
J. McManamy, R. F. of E., Pere Marquette R. R., Grand Rapids, Mich.

SPECIAL PAPER.

"Character of membership that should be encouraged in the Association and steps to secure that membership."

S. L. Yerkes, Fuel Agent, Queen & Crescent System, Lexington, Ky.

SPECIAL PAPER.

"Methods of kindling locomotive fires."

C. F. Richardson, Asst. to G. S. M. P., C., R. I. & P. Ry., Chicago.

SPECIAL PAPER (With Lantern Slides).

"Mechanical Preparation of Fuel."

Professor H. H. Stoek, Professor of Mining Engineering, University of Illinois.

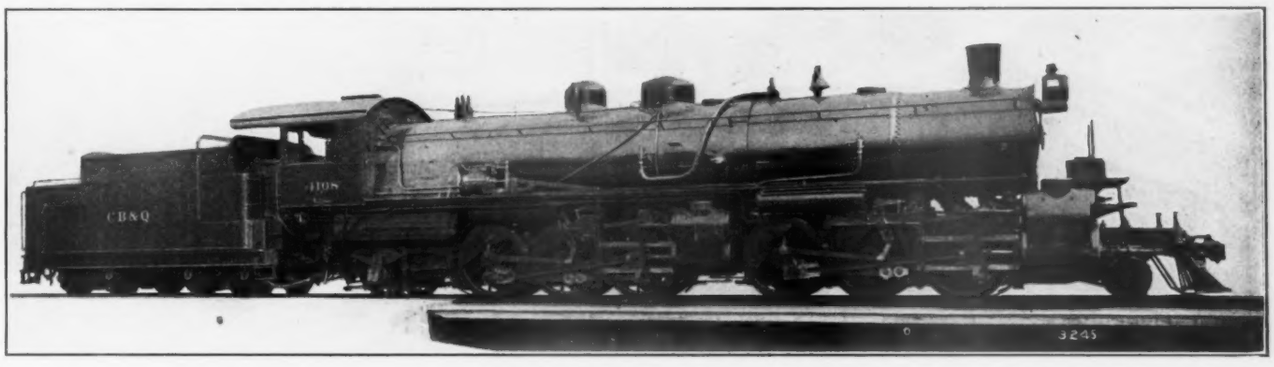
By placing the maintenance of belting in the hands of a specialist, with instructions to prevent failures, not remedy them, and to use only the best quality of material for repairs and renewals, the belting expense in a large railroad shop decreased from $1,000 to $300 per month and the number of failures from 300 to 55 in about 15 months. The conditions before this was done were not worse than in many other railroad shops.

MALLET ARTICULATED COMPOUND LOCOMOTIVE.

2-6-6-2 TYPE.

A GENERAL DESCRIPTION OF LOCOMOTIVE DESIGN WHICH INCORPORATES A VERY LARGE FEED WATER HEATER, A FIRE TUBE SUPERHEATER AND A REHEATER. TEN OF THESE ENGINES HAVE RECENTLY BEEN DELIVERED TO THE CHICAGO, BURLINGTON & QUINCY RAILROAD BY THE BALDWIN LOCOMOTIVE WORKS.

The Chicago, Burlington & Quincy Railroad has had in service for some time eight Mallet compound locomotives of the 2-6-6-2 type of a design very similar to those on the Great Northern Railway, which were illustrated on page 371 of the 1906 volume of this journal. These engines are not provided with superheaters or feed water heaters. The company has recently received ten more locomotives of the same wheel arrangment, which, however, include an Emerson fire tube superheater*, a feed water heater having a heating surface of 2,172 sq. ft. and a reheater consisting of 19 2-in. tubes 128½ in. long located in a large 17 in. flue through the center of the feed water heater. These locomotives are arranged to burn lignite and will be used in freight service on maximum grades of 1.6 per cent. They are designed to traverse 20 deg. curves.



MALLET ARTICULATED COMPOUND LOCOMOTIVE FOR THE CHICAGO, BURLINGTON AND QUINCY RAILROAD. TEN OF THESE HAVE RECENTLY BEEN DELIVERED BY THE BALDWIN LOCOMOTIVE WORKS. THEY ARE ARRANGED TO BURN LIGNITE AND ARE EQUIPPED WITH A HIGH DEGREE SUPERHEATER AND REHEATER AND A VERY LARGE CAPACITY FEED WATER HEATER. THE TOTAL WEIGHT IS 361,350 LBS., OF WHICH 304,500 LBS. IS ON DRIVERS. THEY HAVE 64 IN. WHEELS.

A straight top boiler with a radial stay fire box, having a grate area of 63.8 sq ft., forms the steam generating section of the boiler. The boiler shell contains 218 2¼ in. steel tubes, 16 ft. 6 in. long and 28 5 in. tubes of the same length, which enclose the superheater elements. This gives a total tube heating surface of 2,708 sq. ft., the fire box having 210 sq. ft. of heating surface, making the evaporating surface equal to 2,918 sq. ft. The boiler shell is 78 in. in diameter and the dome is mounted a little ahead of the center of the length of the tubes.

Steam from the throttle valve is carried through the usual dry pipe to the front flue sheet, where it passes through the T head into the two superheater headers. This type of superheater has vertical headers, which are simply enlarged steam pipes with the proper walls and passages to divide the saturated and superheated steam sections. Each superheater has fourteen elements placed in two vertical rows of seven each. The headers have a cross connection at the bottom to act as an equalizer between the superheated steam compartments.

The high pressure cylinders are cast separately from the saddle and the steam from the superheater passes into a short passage in the saddle, from which it is carried by a short elbow pipe to a passage in the center of the cylinders, thence to the 13 in valve chamber. The exhaust emerges from the high pressure cylinders through a 6 in. passage on the back face from which it is carried to a passage in the saddle by a short section of piping and thence upward from the center of the saddle through an elbow pipe to the reheater. The reheater consists of two cast steel headers circular in shape, between which are 19 2 in. tubes 128½ in. in length. These headers have ground ball joints with the elbow pipes at either end. The discharge from the reheater is carried down to the bottom of the smoke box and thence through a flexible receiver pipe to a steel casting which forms part of the front frames and to which the low pressure cylinders are bolted. The construction and arrangement of the passages at this point are the same as were used on the Southern Pacific design, illustrated on page 181 of the May and 367 of the September, 1909, issues of this journal. The low pressure piston valves are 15 in. in diameter.

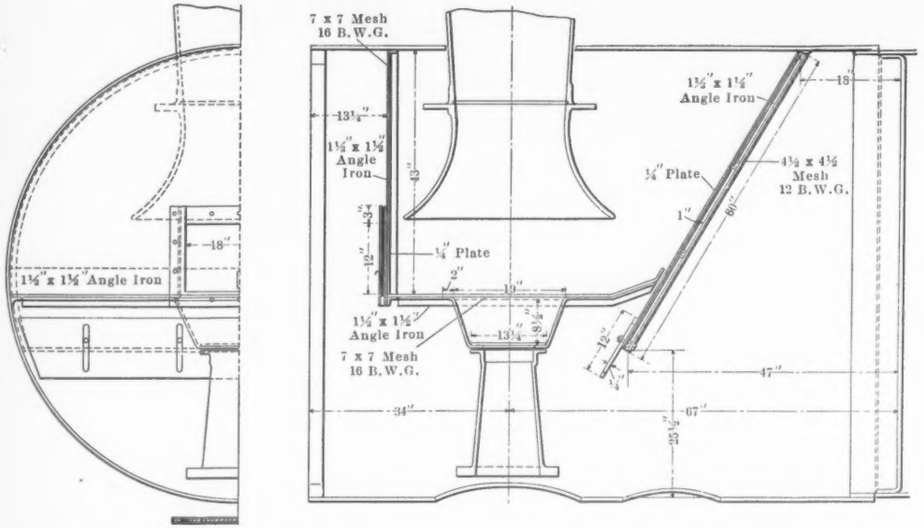
The feed water heater is of unusual capacity and in addition to the large central 17 in. flue has 406 2¼ in. flues distributed over its whole cross section. It is fed by two non-lifting injectors, the admission being on the center line at either side and discharge through a check valve at the top into the check valves on the side of the boiler proper. The front section of the boiler is separable from the rear section, the joint being just back of the feed water heater and all piping or other parts continuing by this joint are arranged to be easily disconnected.

One of the illustrations shows the arrangement of the front end, which the company's experience has indicated to be very satisfactory. The stack has a long interior extension and very large bell shaped section at the bottom, which does not require a petticoat pipe.

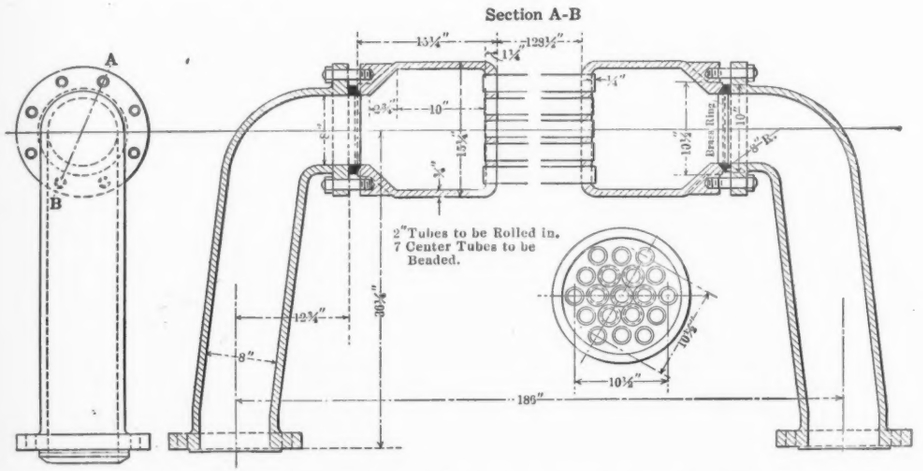
The design and construction of the grates is shown in another illustration. As will be seen, they are designed with very narrow openings in large square rocking frames and are arranged to shake in two sections on either side of the center frame. A small dead grate is provided at either end of the fire box. A single fire door is used.

The frames are of cast steel 5 inches wide, with a single hinge connection. The frames of the rear engine have separate back sections, also of cast steel. The pedestal binders are of the same

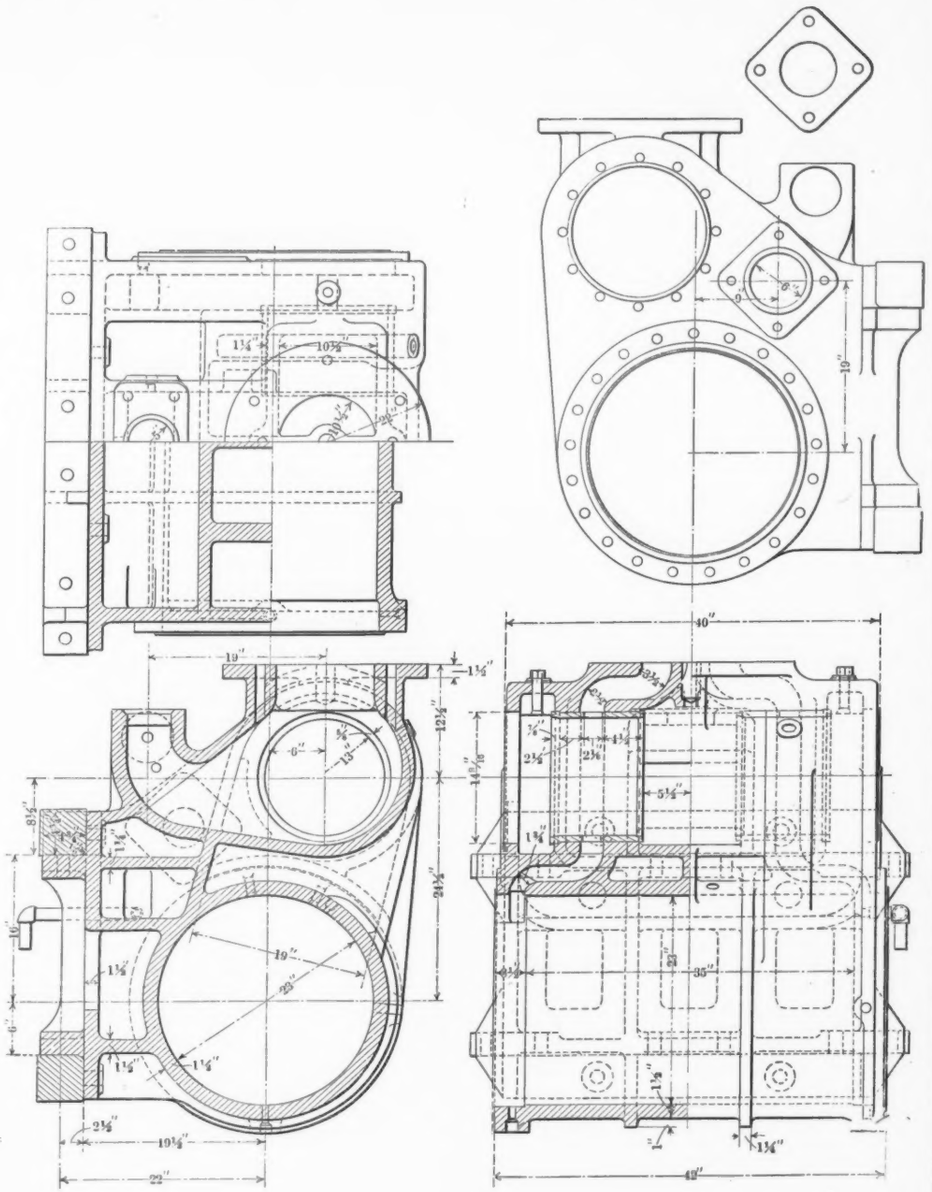
* See AMERICAN ENGINEER, February, 1910, page 64.



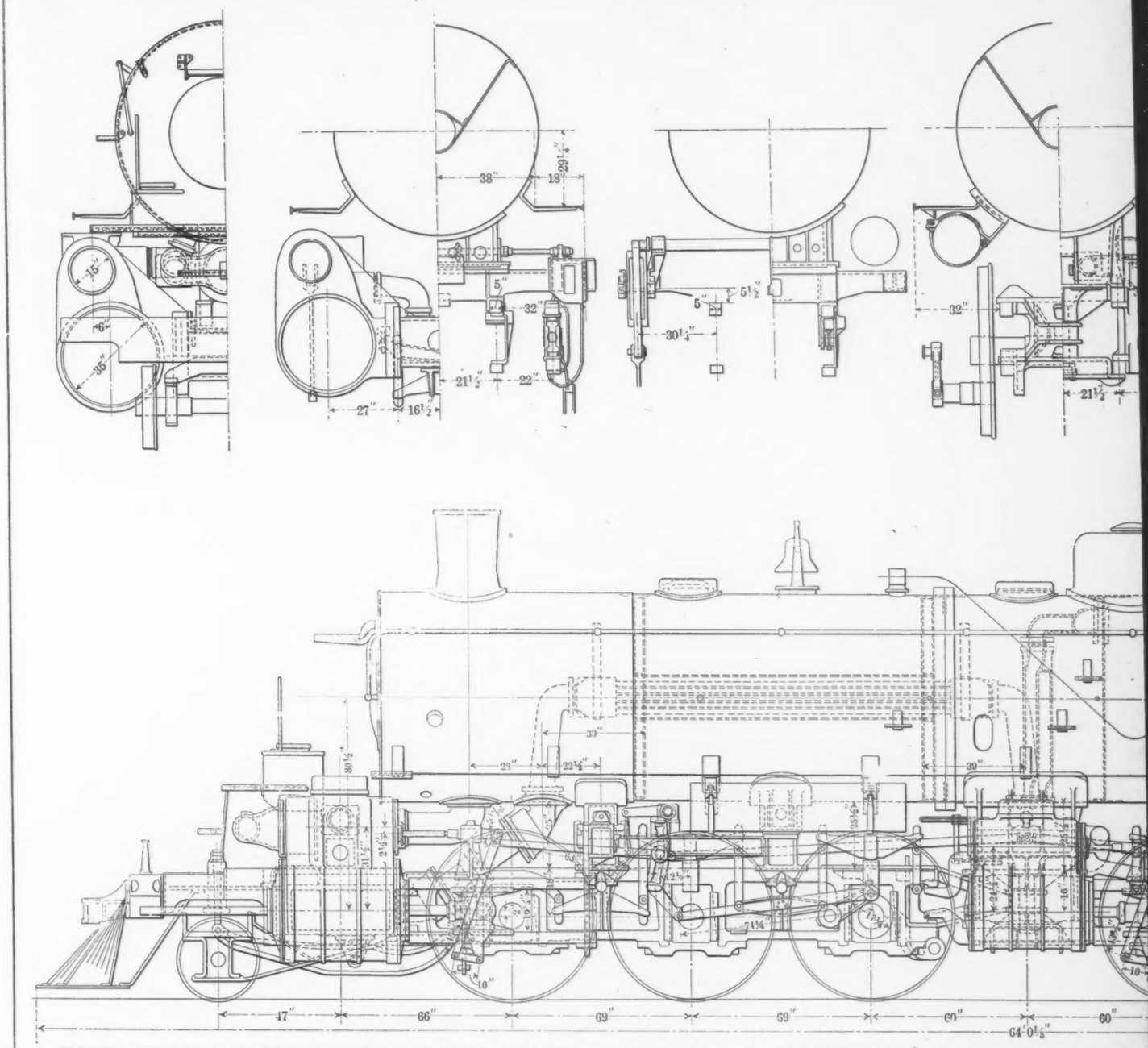
GENERAL ARRANGEMENT OF THE FRONT END OF THE CHICAGO, BURLINGTON & QUINCY MALLET COMPOUND DESIGNED FOR BURNING LIGNITE.



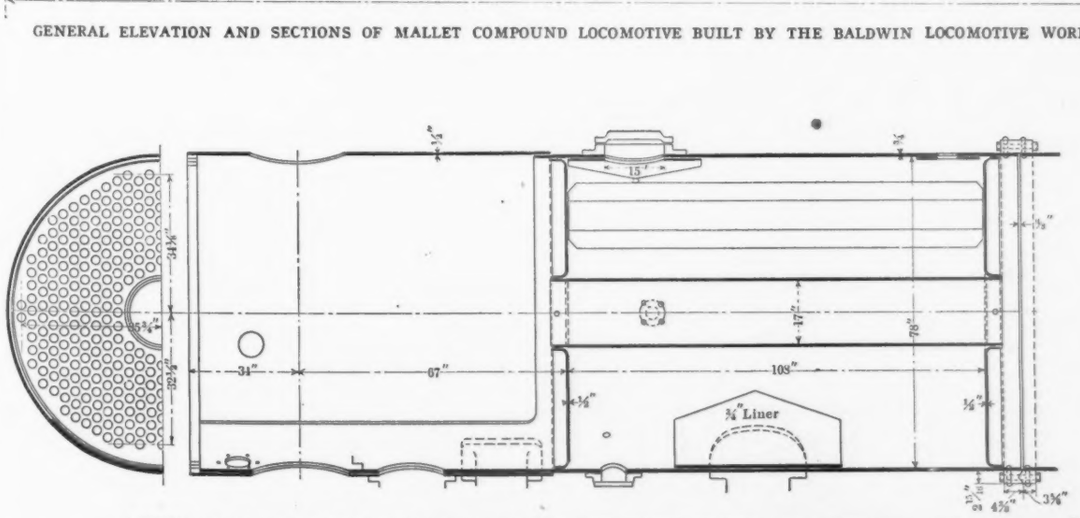
DETAILS OF THE REHEATER HEADERS AND CONNECTIONS AS APPLIED TO THE CHICAGO, BURLINGTON & QUINCY MALLET COMPOUND LOCOMOTIVE. THE TUBES PASS THROUGH A LARGE FLUE IN THE CENTER OF THE FEED WATER HEATER.



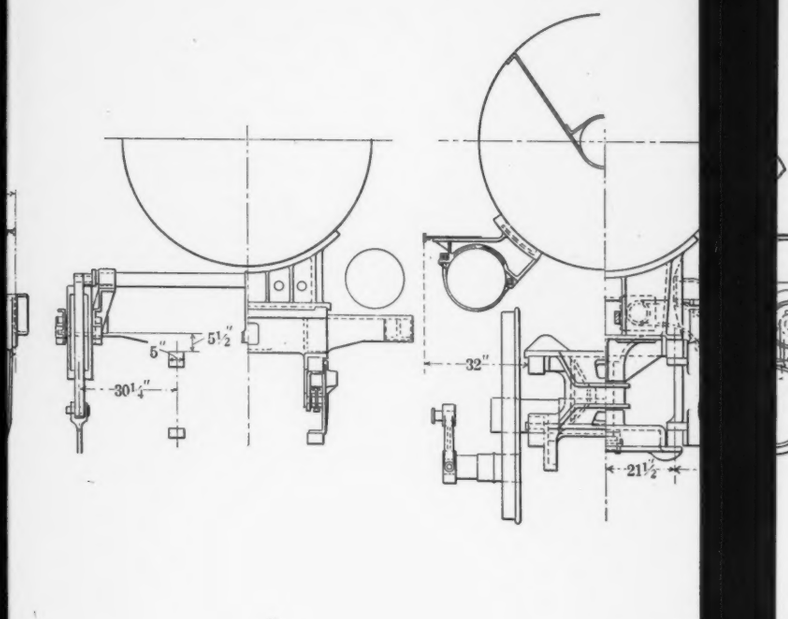
DETAILS SHOWING THE GENERAL CONSTRUCTION OF THE HIGH PRESSURE CYLINDERS; CHICAGO, BURLINGTON & QUINCY MALLET COMPOUND.

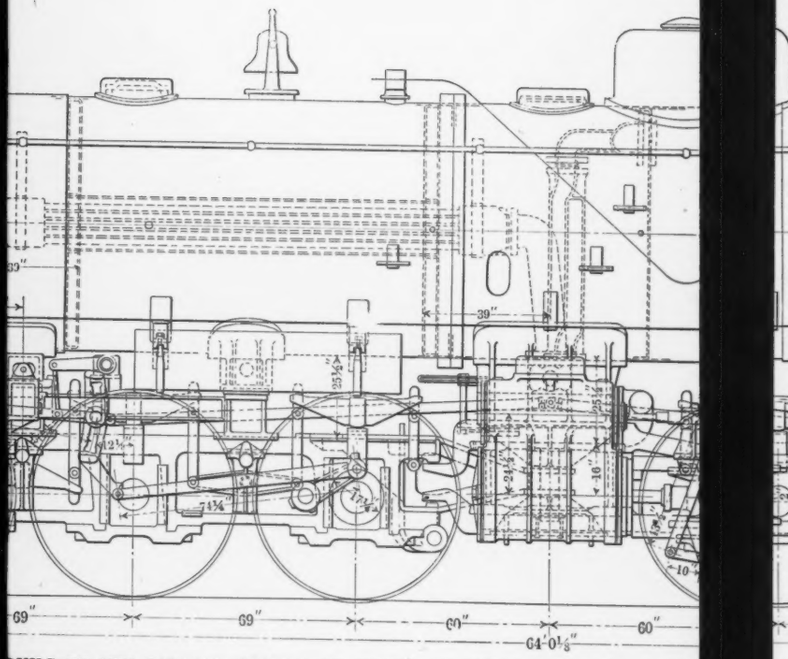


GENERAL ELEVATION AND SECTIONS OF MALLET COMPOUND LOCOMOTIVE BUILT BY THE BALDWIN LOCOMOTIVE WORKS FOR THE CHICAGO, BURLINGTO

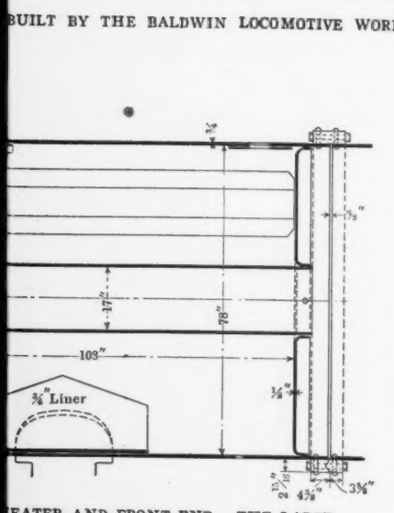


FORWARD SECTION OF THE BOILER SHOWING THE FEED WATER HEATER AND FRONT END. THE LARGE 17-IN. CENTRAL FLUE IS PROVIDED FOR THE REHEATER PIPES.

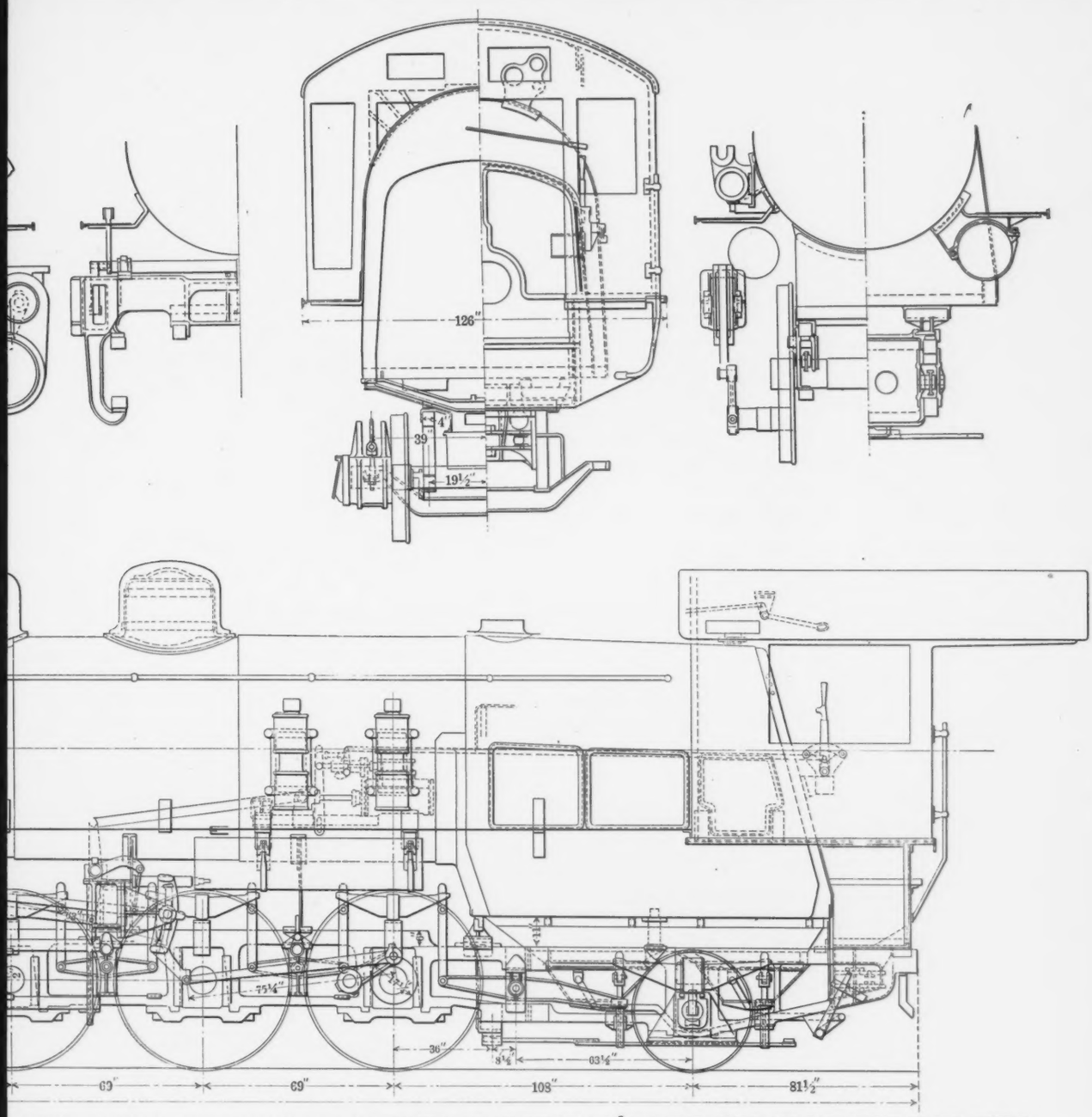




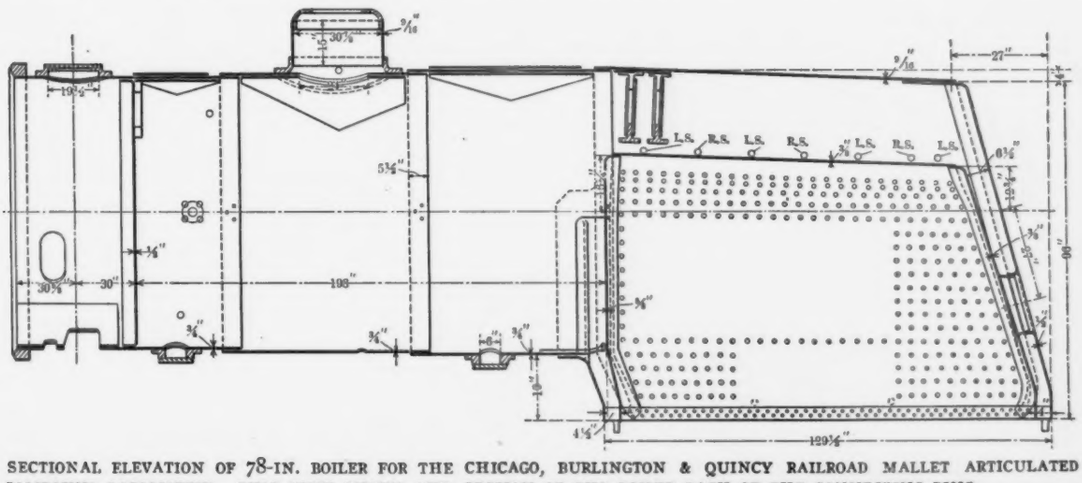
BUILT BY THE BALDWIN LOCOMOTIVE WORKS FOR THE CHICAGO, BURLINGTO



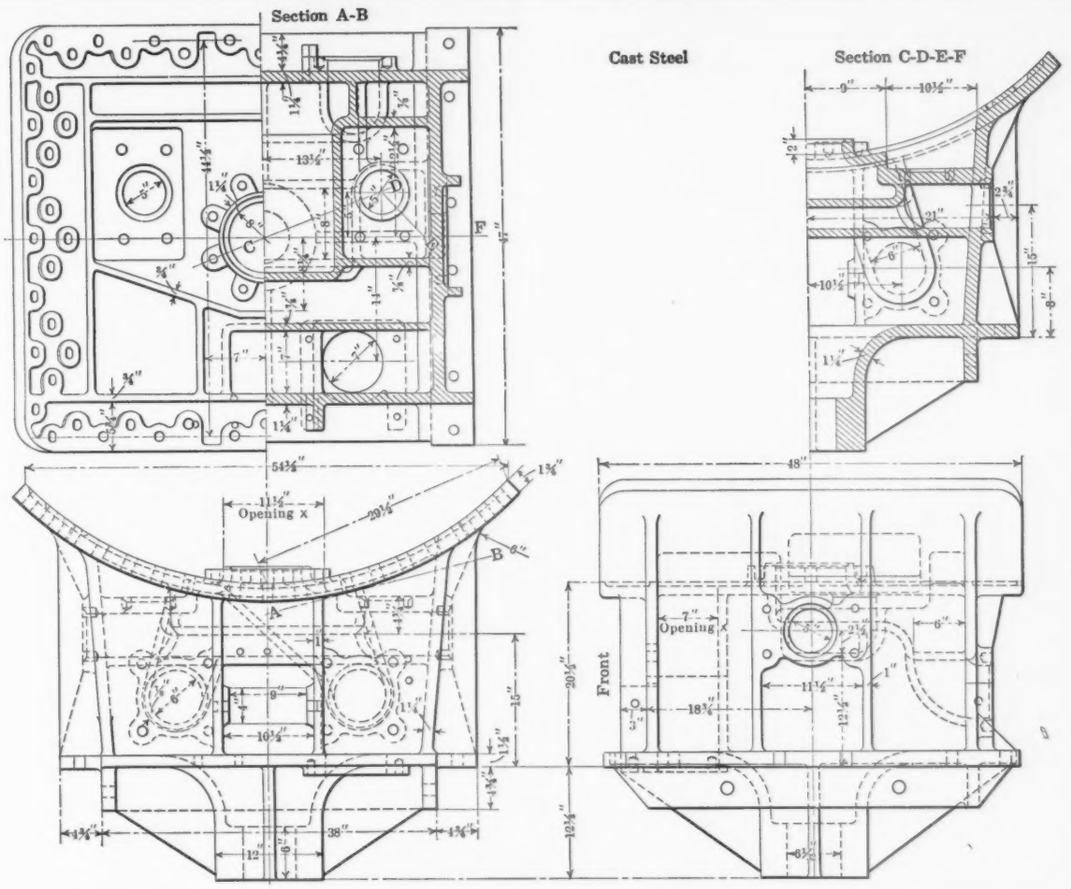
EATER AND FRONT END. THE LARGE
REHEATER PIPES.



QUINCY RAILROAD. THESE LOCOMOTIVES ARE DESIGNED FOR SERVICE ON A 1.6 PER CENT. GRADE AND TO TRAVERSE 20 DEG. CURVES.



SECTIONAL ELEVATION OF 78-IN. BOILER FOR THE CHICAGO, BURLINGTON & QUINCY RAILROAD MALLET ARTICULATED COMPOUND LOCOMOTIVE. THIS VIEW SHOWS THE SECTION OF THE BOILER BACK OF THE CONNECTING RING.



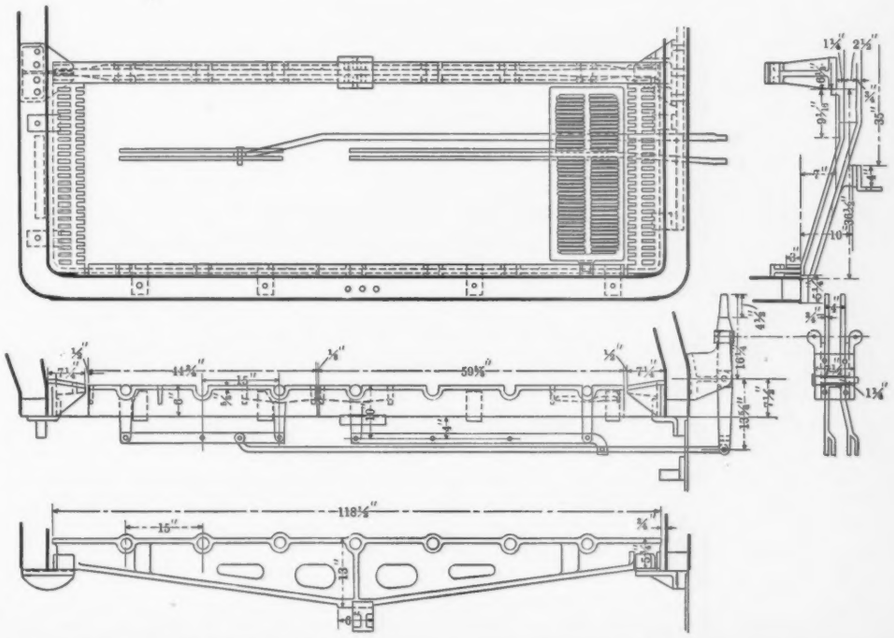
THE HIGH PRESSURE CYLINDER SADDLE SHOWING THE PASSAGES FOR SUPERHEATED STEAM EMERGING ON EITHER SIDE AND THE EXHAUST PASSAGES FROM THE REAR, COMBINING INTO THE 8-IN. OPENING IN THE CENTER, TO WHICH THE CONNECTION TO THE REHEATER IS MADE.

material, and they are lugged and bolted to the pedestals. The front truck is equalized with the leading driving wheels through an inverted leaf spring, suspended from yokes placed over the forward driving boxes. The back end of the equalizer rests on the middle of this spring. The rear truck is of the "Hodges" pattern,* with outside journals. The side swing is taken by the spring hangers, which are jointed for the purpose.

The boiler is supported, on the front frames, by two waist bearers, both of which are normally under load. The front bearer carries the controlling spring, and acts as a support for the low pressure guide bearers. The high pressure guide bearers are bolted to a specially designed steel casting, which also serves as a support for the link bearings. Two waist sheets support the boiler barrel over the rear frames, and the mud ring is carried by sliding shoes in front and a buckle plate at the rear.

Reversing is effected by the Baldwin power gear, and the two reverse shafts are connected by a single reach rod placed on the center line and fitted with a universal joint. Both valve motions are simple in design, and have eccentric rods of ample length. The links of the front engine are trunnioned on cast steel supports, which are placed outside the second pair of drivers, and span the distance between the two waist bearers.

In order to avoid flexible oil pipe connections, the low pressure cylinders are lubricated by two Hart sight feed oil pumps driven from the forward valve motion. The high pressure cylinders are lubricated from the cab in the usual manner.



GENERAL DETAILS OF THE GRATES AND FRAMES OF THE CHICAGO, BURLINGTON & QUINCY MALLET THIS LOCOMOTIVE BURNS LIGNITE COAL AND HAS A GRATE AREA OF 63.8 SQ. FT.

* See AMERICAN ENGINEER, June, 1909, page 228.

The tender is designed in accordance with the Railroad Company's practice. The frame is composed of 12 in. steel channels, and the tank is of the water bottom type. The trucks are of equalized pedestal design, with forged and rolled steel wheels having rims three inches thick.

These locomotives are of exceptional capacity, and the heating surface of the feed water heater is greater than that provided in any engines previously constructed. The principal dimensions are presented in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Lignite
Tractive effort	70,500 lbs.
Weight in working order	361,650 lbs.
Weight on drivers	304,500 lbs.
Weight on leading truck	21,000 lbs.
Weight on trailing truck	36,150 lbs.
Weight of engine and tender in working order	515,000 lbs.
Wheel base, rigid	11 ft. 6 in.
Wheel base, total	51 ft. 5 in.
Wheel base, engine and tender	83 ft. 2½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.33
Total weight ÷ tractive effort	5.13
Tractive effort x diam. drivers ÷ boiler heating surface	1,550.00
T. E. x D. D. ÷ boiler and feed heating surface	890.00
Total boiler heating surface ÷ grate area	45.70
Fire box heating surface ÷ total boiler heating surface, per cent	7.10
Weight on drivers ÷ total boiler heating surface	104.00
Total weight ÷ total boiler heating surface	123.50
Volume equivalent simple cylinders, cu. ft.	24.10
Total boiler heating surface ÷ vol. equiv. cylinders	120.59
Grate area ÷ vol. equiv. cylinders	2.65

CYLINDERS.

H. P. Diameter	23 in.
L. P. Diameter	35 in.
Stroke	32 in.

VALVES.

Kind	Piston
Diameter H. P.	13 in.
Diameter L. P.	15 in.

WHEELS.

Driving, diameter over tires	64 in.
Driving, thickness of tires	4 in.
Driving journals, diameter and length	10 x 12 in.
Engine truck wheels, diameter	30 in.
Engine truck, journals	6 x12 in.
Trailing truck wheels, diameter	42½ in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	78 in.
Firebox, length and width	120 x 78¼ in.
Firebox plates, thickness	⅜ and ⅝ in.
Firebox, water space	F-4½, S and B 4 in.
Fire tubes, number and outside diameter	28-5 in., 218-2¼ in.
Fire tubes, length	16 ft. 6 in.
Heater tubes, number and diameter	406-2¼ in.
Heater tubes, length	8 ft. 11 in.
Heating surface, fire tubes	2,708 sq. ft.
Heating surface, firebox	210 sq. ft.
Evaporating heating surface, total	2,918 sq. ft.
Superheater heating surface	464 sq. ft.
Feed water heating surface	2,172 sq. ft.
Grate area	63.3 sq. ft.
Centre of boiler above rail	114½ in.

TENDER.

Tank	Water bottom
Frame	12 in. chan.
Wheels, diameter	37 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	13 tons.

LONGITUDINAL JOINTS IN BOILERS.

To the Editor:—

A paper on "The Best Form of Longitudinal Joint for Boilers," by F. W. Dean, was published in the *Journal* of the American Society of Mechanical Engineers for October, 1909. It recommends as a substitute for the usual form of butt joint in which the outside strap is narrower than the inside one, a joint having the straps of equal width, both to take all rivets and made of sufficient thickness to stand caulking between the widely pitched rivets of the outer row. The author gives an example of a joint of the usual kind, with which an explosion was narrowly averted.

The discussion, which was adverse to the recommended joint, was printed in the *Journal* for March, 1910. The following were the principal arguments against it: (1) According to the customary formulas it is less efficient. (2) It is stiffer, and will cause more injury to the plate outside the joint, by buckling with changes of temperature and pressure. (3) Greater loads are thrown on the rivets of the outer row by caulking on the longer pitch. (4) The tension in the inner butt strap tends to distort it.

Believing that the principles involved, acting as they do, not only in boiler joints but in all riveted and bolted connections, are of such vital importance to life and property as to deserve thorough study, I submit the following comments:

The present formulas used in calculating the strength of these joints are based on at best two serious fallacies: they assume that the shear is distributed evenly among the shearing sections of the rivets, and they assume that the tension is evenly distributed through any longitudinal section of the plates. In the design of joints it should be sought to prevent the stress in any parts of them from being so high as to cause deterioration of the material when subjected to long, continued use under varying loads. If the stress is not so limited, the material loses strength and cracks start. The load is then thrown on some other portion of the joint, which in turn fails, transferring the load still farther until the last, vital section of the metal lets go. If this joint had, when new, been tested in the testing machine, the ductility of the metal would have allowed the different members to yield until a distribution of stress was obtained, which was much nearer that assumed in the formulas. That the assumptions are not even approximately correct is apparent in some of the simpler cases. In the plain lap joint, for example, the bending must produce a tension at the surfaces of the plates in contact several times as great as it would be if evenly distributed, while the opposite surfaces of the plates are probably in slight compression. The heads of the rivets may transfer this locality of maximum stress to a point beyond that of least net section. Thus joints have failed which, according to the usual formulas, were three or four times as strong as necessary. In the more complicated joints the distribution of the shears will depend upon the elasticity of the rivets, the slipping of the plates, and the relative stretch of the plates and the straps. The foregoing will make clear that any comparison of joints by means of these formulas is far from conclusive. (The suggestion is made that much can be learned from the testing machine by measuring distortions of the joints under the loads they are suited to carry.)

In the usual form of butt joint the outer row of rivets exerts a one-sided pull, disturbing the distribution of the stress, and tending to bend the plate just outside the joint. This may be the effect described as the "buckling," which is admitted to be a fault with this joint. It is very difficult to see how mere expansion and contraction of a circular shell could produce buckling. If the writer's view of this is correct, it follows that the symmetrical joint used by Mr. Dean is an improvement. Of course any buckling would show its effects first at the ends of the joint.

The tension due to the cooling of the rivets is undoubtedly more than enough to provide for the loads described in the discussion, and the rivets are probably not subjected to additional tension in either joint.

The change in direction of the circular tension between two rows of rivets is very slight, even in small boilers. The effect on the butt strap is merely that of an eccentric load, most severe midway between the rows of rivets. Obviously its effect is less with the thicker strap, and is very slight compared with the eccentric load thrown on the plate by the outer row of rivets when not supported by the outer butt strap.

The fact may be of interest that a form of joint having an outer strap with its edges scalloped around the rivets of the outer row, is in service on the Danish State Railways.

A study of the faults of the lap joint and the application of the principles to the butt joint must lead one to conclude that the joint described by Mr. Dean is better than that now commonly used.

G. E.

$100,000,000 INCREASE IN WAGES.—President W. C. Brown estimates that the railway wage advances already made or soon to be made will amount to $100,000,000 yearly for the entire country.

ECONOMIC LOSSES DUE TO MINE SUSPENSIONS.

By Eugene McAuliffe.

Much has been said regarding fuel economy. Text books have been written, bought and read; lecturers have discoursed at length on the subject, and in some cases railroads have gone to the expense of equipping or leasing instruction cars, which, manned with a corps of instructors, were moved over the road, giving engineers and firemen a chance to receive oral instruction on this most important subject. Traveling Engineers and their assistants have labored to develop a degree of skill on the part of enginemen, and master mechanics have employed their best efforts in designing front ends, valve motion, compounding systems, and, last of all, the superheater; all with the view of effecting a degree of saving in the fuel account. If this work is not being well done it is because of the pressure of other things. We all realize at least that the field is a fertile one.

While we are battling manfully in the direction referred to, we are asleep, insensible, to greater losses to the fuel account that take place before the coal is put on the locomotive. I refer to the mine suspension, a biennial institution, too mild an affair to deserve the dignity of being called a strike, but which we look forward to as an event to be dreaded, for months, then met in a slam, bang, crash, kind of hurry by buying what we can get, where we can get it, and at what price we can get. If any railroad or large industrial consumer will pause long enough to tabulate their extra coal purchases made in February and March preceding a suspension, the result will provide food for thought. He will find that the prices paid bear *no relation* to the comparative value of the material furnished, often fluctuating as much as twenty-five per cent. in two or three days, this in the case of coal of a common character, coming often from the same mines. If he will compare notes with his neighbor he will find an absolute lack of similarity in prices paid, suggesting that it is not supply and demand that regulates the price making, nor is it cost of production, but rather the ability of the seller to stampede, and the capacity of the buyer to be stampeded, that governs.

Back of this loss comes the other great losses suffered by the operating and traffic ends of the railroad, great enough in the aggregate to stun a whole railroad organization if it were not that the whole calamity is looked upon as inevitable. Among these items might be mentioned the taking out of revenue service coal equipment, a part of which is employed in moving material for building purposes ordered to meet the spring construction period; the rush and hurry of this equipment to mine districts regardless of loading, the clogging of side tracks and terminals on portions of the line due to concentration with consequent loss of efficiency of power, cars and men. In the past sixty days cars have been rushed out of mines without scale weights, the way-bill stamped "weigh en route," cars eventually reaching the storage pile without weights. Pennsylvania steel billet cars with a twelve inch sideboard and with a load of twenty-five tons, billed at a capacity weight of fifty tons, all overlooked in the rush incident to "getting the stuff." It seems farcical for a railroad fuel department or coal producer to work all summer toward securing refinement in weighing and grading coal, only to see several months work broken down in six weeks. Then comes the aftermath, the loading up of coal dumped promiscuously on the ground with a loss for labor, theft, and deterioration in quality, frequently amounting to fifty cents per ton, the breaking down of the operating organization in the mine districts, crews pulled off, weigh-masters and station forces reduced to meet reduction in revenue, all of which must be rebuilt in a few weeks when work resumes and the storage piles are burned up.

It might be well to pause and ask ourselves, Why all this confusion? The last campaign is too fresh in our memories to require a detailed answer, although the struggle has been a bloodless and almost a noiseless one. At the date of publication thirty days from the writing of this communication, the mines will all be at work, at least those which have work to do, some of them idle perhaps waiting for their customers to finish consuming their stock piles.

The coal operators and mine workers in a portion of Pennsylvania, all of Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, Oklahoma and Texas, work under agreements that expire simultaneously, *i. e.*, March 31st; the last one of two years' duration, and made in April and May, 1908, during a suspension varying from three to eleven weeks in length, during which time the railroads and industries, as well as domestic consumers, were supplied from storage piles or by coal moved from the non-union districts of West Virginia, Kentucky, Alabama and Colorado, with a considerable east bound movement from union mines in Wyoming working under a wage scale expiring September 1st. All of this outside coal is bought at the expense of a premium due to long haul and much of it is hauled over the rails of roads consuming it at a material expense to the transportation department; this expense not included in the item of fuel cost as defined by the Interstate Commerce Commission. It does not take a far-seeing man to recognize the great economic loss due to this procedure, and while it is a patent fact that coal brokers and others use the anticipated shutdown for price exploitation purposes, the stable producer of coal who owns and operates mines in the suspended territory is ultimately a loser, due in part to disorganization of working forces and loss of business to the non-union districts, as well as to the fuel oil and natural gas fields, but more so to the fact that during the suspension period and after work is partially resumed his Sales Department, under pressure to get business, frequently takes contracts at a price insufficient to cover the cost of production and maintain and replace the depleted property. In this way the money taken in the shape of premium is lost to the producer, the jobber alone retaining his profit. This conduct spells nothing less than attack and reprisal, and savors more of the Algerian piracy of 1795 than good business methods.

Trade journals magnify these anticipated and recurring troubles, seeking to justify a line of business conduct that is in the long run neither defensible or profitable. There is no doubt but that the average price paid for coal in the Mississippi Valley field has for some years been too low, this due to an excess production, the price fixed by a minority of the producers, but necessarily governing the whole. What the coal trade wants is an earnest effort to eliminate the conditions attendant on the making of wage scales that serve to cover the abuses referred to, and the money lost by the consumer in storing and hauling coal would, I am sure, be willingly paid to the producer if the proper presentation was made, at least by the railroads who are certainly managed by men of sufficient foresight to see that the wreck of an industry as important as this is, means an ultimate loss to the railroad.

The writer has been asked, in what direction does the remedy lie? He is a poor student of the times who does not recognize the fact that in the case of industrial disputes, whether transportation, manufacturing or mining, the greatest sufferer, and the one who is least considered, is the public, the great mass who depend on the industry for some facility or commodity. What the people want to insure industrial peace is "the limelight," a poor cause will then yield to that most potent ultimate force, public opinion—a jury trial—the public the judge. Let

the operators and the mine workers cease making contracts to expire at a given date, instead make them subject to cancellation on thirty days' notice on the part of either subscriber, with a clause providing that operation will be continued for ninety days after cancellation and pending the negotiation of a new wage scale. Supplement this arrangement with an effort to secure the passage of an arbitration act either an amplification of the Erdman act covering disputes incident to interstate transportation, making it applicable to all industries, or, better still, secure an act patterned after the Canadian Act, which, since its enactment three years ago, has resulted in a condition well covered by the following letter written under date of August 31, 1909, by the Honorable MacKenzie King, Minister of Labor of the Dominion of Canada:

"Having just returned from New York, I find your communication of the 26th inst., requesting information in regard to our Industrial Disputes Investigation Act.

"I have asked the Deputy Minister to forward you copies of the measure, and also information in regard to the workings of the Act, which I think may be of service to you.

"In the September number of *McClure's Magazine* you will find an interesting article by Dr. Eliot, President Emeritus of Harvard University, dealing with the workings of the Act during the first two years of its existence.

"I regret to say that so far as coal mines are concerned, the Act has not been entirely successful in averting all industrial disputes. In connection with the agencies of transportation, such as railways, telegraphs, street railways, etc., it has given the country an all but complete immunity from the cessation of industrial operations for a period of nearly two years and a half; in connection with mines, it has averted some strikes entirely, and in almost all cases has prevented a sudden cessation of operations.

"There have been, however, cases in which one or other of the parties, not being satisfied with the awards of Boards, have endeavored to enforce their demands by the old weapon of the strike; most of such strikes have been concerned, primarily, with the question of union recognition. Where the question has been one, rather, of conditions of employment, the Act has been of almost as great service in connection with mines as in the case of disputes in other industries.

"I hope you will find the reports, which are being forwarded, of some service."

With a view of making further explanation of the workings of this beneficent act, I quote in part from the article written by Charles W. Eliot, President Emeritus of Harvard University, published in *McClure's Magazine* of September, 1909, and referred to by Mr. King:

"The chief feature of the beneficent Canadian Act, called the Industrial Disputes Investigation Act, was the requirement that, in the event of a dispute arising in any industry known as a public utility, it should be illegal to resort to a strike or lockout until the matters in dispute had been made the subject of an investigation before a Board of Conciliation and Investigation, to be established under specified rules by the Canadian Minister of Labor. Under this Act, either party to a dispute may apply for the appointment of a Board of Investigation. Each of the two parties to the dispute may nominate one member of the Board, and these two may select the third, who serves as chairman of the Board of three. If either party fails to nominate a member, the Minister of Labor appoints that member, and if the two members fail to agree upon the third member the Minister appoints the third member. The Board will therefore inevitably be constituted, and will go to work, if either party to the dispute applies for an investigation. The proceedings of every Board appointed and its final report are published throughout the Dominion in the most complete manner.

"During the two years from March 22, 1907, to the end of March, 1909, fifty-five applications were received for the appointment of Boards, under which forty-nine Boards were set up. In the remaining six cases the disputes were settled, either during the discussion arising out of the application, or during the formation of the Board; but these six cases of prompt settlement are obviously due to the influence of the Act—that is, to the prospect of complete publicity with regard to the causes of the dispute and the claims of the disputants. The fifty-five applications were distributed as follows: Concerning mines and smelters, 30; concerning transportation, or means of communication, 23; concerning disputes in industries which were not public utilities, 2. In these two cases both parties to the industrial dispute applied for an investigation, the Act providing that its benefits may be extended to industries other than public utilities, if both parties, instead of only one, make application for the establishment of a Board.

"On the fifty-five applications received, strikes were avoided or ended in twenty-five coal mines, and four metalliferous mines, in fifteen railroads and three street railways; in two bodies of longshoremen, in one body of teamsters, and in one body of sailors, and in two industries not public utilities. There were two cases in which strikes were not averted or ended. Only two cases, therefore, out of fifty-five utimately resulted in strikes, these two strikes being in perfect accordance with the wise terms of the Act, which permit owners to lock out their men and workmen to strike after the public investigation has been completed and its results published.

"The official reports (see the *Labor Gazette*, issued monthly by the Department of Labor, Ottawa, April, 1909, pp. 1080-91) make it plain that some of these disputes were serious, affecting directly large numbers of persons and indirectly threatening the common welfare. Among the strikes in mines may be mentioned that on the Cumberland Coal Company, with 1,700 men concerned; that on the Crow's Nest Pass Coal Company, in which 1,800 men were involved; that on the Dominion Coal Company, January 4, 1908, with 7,000 men affected; that on the Nova Scotia Steel and Coal Company, with 1,750 men affected, and that on the Dominion Coal Company on March 4, 1909, with 3,000 men affected.

"To the question whether the Industrial Disputes Investigation Act has been effective the clear answer is that since its enactment, in March, 1907, the Dominion has known no cessation in the continuous operation of any of its great agencies of communication—steam railways, electric railways, telegraph and telephone lines, or other public utilities of the kind—and the national industries and the public have not suffered any inconveniences other than a few of a purely temporary and local nature through the cessation of some mining operations. This remarkable record may not be continuously maintained; but it seems quite possible that never again will the interests of the Canadian public be injured through the threatening or actual outbreak of sudden and extensive industrial conflicts, such as frequently occurred in Canada prior to the enactment of the law, and still occur, with enormous and widespread damage, in the United States."

The investigation of this act by Mr. Eliot, a man of recognized character as a student of economics, suggests that we, as a people, are sadly in need of some similar legislation. A strike is war, getting ready for one that may not come is a crime, and it is time to call a halt. For the past three months the managers of four score of railroads have worked to settle wage disputes—arbitration was the weapon used; if these gentlemen will give one-fourth of the effort spent by them in the past winter on this other wage question, the abolition of the stock pile as an insurance against coal strikes will be accomplished, and with a proper presentation, the responsible coal operator will be glad to join forces to accomplish this end.

A FIELD FOR THE PRODUCER-GAS POWER PLANT.

In the United States cheaper power is constantly sought. The water-power possibilities of the country are being realized and the hydro-electric power plant is a wholesome cause of competition. The supply of fuel of marketable grades is not unlimited. Prices for such fuel must of necessity increase. The cost of transporting coal from the mines is high, and the possibility of obtaining a sufficient supply of cars to handle low-grade fuels is questionable. The power demands of the country are increasing, and this power must be developed at a reasonable cost. The time is approaching when the cheapest fuel obtainable must be used to the best economic advantage in order to develop power at a unit cost consistent with commercial progress.

Consideration of the conditions indicates that in order to keep the price of power developed from fuel down to a consistent figure—

(*a*) Grades of fuel which warrant transportation, or which may be defined as "marketable," should be used with the greatest practicable economy.

(*b*) The very large percentage of coal of so-called low grade which to-day is left at or in the mine must be utilized.

(*c*) Advantage must be taken of the large deposits of lignite and peat which are found in many sections of the country.

It is undoubtedly true that in general, under conditions which do not require the use of steam for other than power purposes, the producer-gas power plant meets the requirements of (*a*).

At present the only method of advantageously handling the fuels mentioned in (*b*) and (*c*) is in the gas producer, and the utilization of these lower grades of fuel on an extensive scale demands concentration of the power plants within close proximity to the fuel supply.

The logical conclusion from a careful study of the producer-gas power situation is that the time is not distant when financial interests in power production will be directed toward the centralization of the producer-gas power plant at the mines and the distribution of the energy developed either by high-voltage long-distance electrical transmission or by pipe systems for conveying the gas.—*From Bulletin 416 on "Recent Development of the Producer-Gas Power Plant in the United States," by R. N. Fernald, issued by the U. S. Geological Survey.*

COST OF HANDLING LOCOMOTIVE FUEL SUPPLY.

A DETAILED INVESTIGATION AND DISCUSSION OF THE VARIOUS ITEMS THAT MAKE UP THE COST OF TRANSFERRING COAL FROM THE MINE SIDING TO THE LOCOMOTIVE TENDER.

By Raffe Emerson.

[EDITOR'S NOTE.—IN THE RAILWAY NUMBER OF CASSIER'S MAGAZINE (MARCH, 1910,) MR. EMERSON PRESENTED AN ARTICLE UNDER THE TITLE OF "RAILWAY FUEL SUPPLY," OF WHICH THE FOLLOWING IS A LIBERAL EXTRACT, PRESENTED BY THE PERMISSION OF THE PUBLISHERS.]

One-quarter of the coal mined on the North American continent is used by its railways, the 60,000 locomotives in the United States alone taking over one hundred million tons each year at a rising price (1909, about $2 per short ton).

This expense for locomotive fuel is practically a tax of one cent a day on every man, woman and child in the country. Any means for reducing this growing cost, in however small degree, is worthy of the interest, attention and consideration of all the people as citizens, as well as of statesmen, financiers, economists, railroad men and engineers.

Five per cent. of this huge fuel bill (that literally consumes nearly the hundredth part of the people's wealth every year) is a charge against it that does not add in any material way to the fuel value of the coal burned, but rather the reverse, namely, the cost of loading this fuel onto locomotive tenders out of cars from the mines. This expense averages fully twice what it demonstratedly should be (could be, and in places *is*), and its reduction, through the use of efficient modern types of fueling stations, would bring about as correlative benefits a great decrease in the amount of human labor now spent in the dirtiest, most back-breaking toil, and would also eliminate much crumbling and deterioration of the coal from unnecessary handling.

To load fuel on locomotives costs roughly 8 cents a ton, the average being more nearly 10 cents. In actual instances it may get under 4 or 5 cents, and I firmly believe that a figure between 1 and 2 cents is not chimerical to hope for, nor an average figure of 3 cents a ton, covering all direct costs including interest and depreciation, an unreasonable expectation for the developments of the next year.

The present average charge is about as follows:

	Cents per Ton to be Handled.
Interest and depreciation	3.0
Maintenance	1.0
Labor	6.0
Supplies	0.0
	10.0

Discussing these items in turn, we find that the interest and depreciation depend principally on the capacity of the fueling station in tons handled per day, for a given investment, and secondarily upon the durability of the structure and apparatus. The following table shows the interest and depreciation, figured at three rates in fueling plants per ton capacity per day. This table makes it very easy to determine the amount to add to the cost of handling fuel in order to arrive at the full cost per ton including interest and depreciation at a given rate. The investment cost of the fueling station is divided by the average daily tonnage issued to locomotives, giving "investment per ton capacity," and the intersection of this line, with the selected "Interest and Depreciation" column, gives the cost per ton of the latter.

Investment per Ton Daily Capacity, Dollars.	Interest and Depreciation in Cents per Ton Loaded on Locomotive at a Rate Yearly of		
	8 Per Cent.	12 Per Cent.	20 Per Cent.
5	.1	.2	.3
10	.2	.3	.6
20	.4	.7	1.1
30	.7	1.0	1.7
40	.9	1.3	2.2
50	1.1	1.7	2.8
60	1.3	2.0	3.3
70	1.6	2.3	3.9
80	1.8	2.6	4.4
90	2.0	3.0	5.0
100	2.2	3.3	8.3
120	2.7	4.0	6.7
150	3.3	5.6	5.6
200	4.4	6.7	11.1

The figures between the heavy lines indicate usual ranges, and the heavy-face figures what may be considered good standard practice. From this table a very simple rule governing fuel station investment, or investment in fueling station improvements, may be derived.

Find the cost per ton of the interest and depreciation charge on the proposed investment and see whether it is substantially less than the saving in handling cost effectably by making the investment.

The durability of the station and accessories also affects the maintenance charge to a large degree. In this charge probably the "fire risk" should be properly included. In a modern station the maintenance should be low—less than 1 cent per ton handled, ¼ cent being an entirely practical and attainable figure.

	Cost per Ton in Cents. Minimum.	Average.	Maximum.
Unloading from car	0.03	2	10
Operating fuel station	0.1	1	5
Loading on engine	0.2	3	15
Total	0.3	6	30

Labor may be subdivided into elementary operations (sometimes combined, or still further subdivided) as indicated by the preceding table.

An automatic balanced bucket type of fueling station, served by the very best self-clearing coal cars, handling 250 tons in twenty-four hours, and using the services of one man but half a day, coal being taken by gravity by the locomotive firemen, would give the minimum cost above indicated.

Supplies are a considerable item only in mechanical or power crane or hoist-drum types or station. This charge will run from practically nothing to 1 or 2 cents per ton, according to fuel or power used. Properly to be considered in this item, although not so charged in the Inter-State Commerce Commission's Official Classification of Railroad Accounts, is the cost of switching service, placing cars on trestles, setting them, withdrawing empties, etc. This service is worth about $2 per hour, and as an average yard locomotive will handle from two to twenty cars per hour, in or out (average about six, allowing for locomotive in service day and night), the cost per ton will be about ½ cent to about 5 cents, and an average about 2 cents per ton.

Three mighty important aspects of this problem, amounting to a much greater money value than the entire cost of handling the fuel, direct and indirect, are usually but little considered, because railway accounts are kept to show money expenditure rather than time expenditure, notwithstanding that in transportation, in the use of equipment—cars, locomotives—for handling a volume of traffic, *time is money*. These three aspects are:

Detention of locomotives for coaling;

Detention of coal cars for unloading;

Transportation cost of company's supply fuel in cars over company's own lines (such freight charges being over foreign or other lines about one-half of the average $2 per ton cost of railway fuel).

A fourth item of great importance, which may equal or perhaps exceed the handling charge, is the deterioration and crumbling of the coal, due to the way it is handled and re-handled.

These four large items of correlative cost, affected by the way the fuel is handled at the fueling station, range about as follows (locomotives are worth in earning power from about twenty to *several hundred* dollars per day; an average tenderload of coal will be from 4 to 15 tons, say about 7.)

(Cars earn from $1 to about $10 per day, average being about $3.)

Locomotive Detention in Minutes.	Value of Locomotive Time in Earning Power, per Detention per Ton of Coal Loaded. Values in Cents. Minimum.	Average.	Maximum.
Minimum: 1.....	0.1	0.8	5.0+
Average: 12.....	1.0	9.0	50.0+
Maximum: 6 hours.....	25.0	$3.00	$30.00+

Car Detention for Unloading.	Value of Time in Cents per Day Detention per Ton of Coal Unloaded. Minimum.	Average.	Maximum.
Minimum: 10 min. +.....	...	0.5	0.25
Average: 8 days	16.0	60.0	$3.00
Maximum: 20 days +.....	40.0	$1.50	$10.00

Cost of transportation will vary from less than 0.1 cent per commodity ton mile to over 3 cents, and average about 0.3 cent. Taking the average figure, the following table gives the cost of hauling railway fuel per ton of fuel for distances one mile tc one thousand miles:

AVERAGE COST OF HAULING ONE TON OF COAL, IN DOLLARS.

Miles.	Cost.	Miles.	Cost.	Miles.	Cost.
1.....	$0.003	10.....	$0.03	100.....	$0.30
2.....	.006	20.....	.06	200.....	.60
3.....	.009	30.....	.09	300.....	.90
4.....	.012	40.....	.12	400.....	1.20
5.....	.015	50.....	.15	500.....	1.50
6.....	.018	60.....	.18	600.....	1.80
7.....	.021	70.....	.21	700.....	2.10
8.....	.024	80.....	.24	800.....	2.40
9.....	.027	90.....	.27	900.....	2.70
10.....	.030	100.....	.30	1000.....	3.00

The relation of fuel value to economical transportation zone has been elaborately developed in a thoroughly practical way by Mr. Crawford, of the Chicago, Burlington & Quincy Railroad, and those interested are referred to his paper before the Western Railway Club of Chicago.*

"Run-of-mine" coal is generally bought for locomotive use, both because it is cheaper per ton and because its purchase helps the mine operator to dispose of an otherwise often unmarketable product (this policy being a practical conservation measure). "Run-of-mine" will "run" 25 to 60 per cent. of slack, the average being over 35 per cent. "Run-of-mine" is priced from 10 to 30 cents per ton less than screened coal. Each per cent. of slack is therefore worth a price difference of about ½ cent. Every handling of the coal will result in a breakage or crumbling of one to three per cent., and will run as high as eight per cent. with some types of mechanical plants. As each ton of coal is handled from one to three or more times from car to tender, averaging twice, the deterioration in value due to crumbling amounts to from ½ cent to 4 or 5 cents a ton, averaging between 1 and 2 cents.

The reduction in steaming capacity will be about half of the cinder percentage—thus 10 per cent. cinders will reduce the locomotive efficiency by about 5 per cent. compared with the use of a cinderless fuel. As the locomotive is worth from twenty to several hundred dollars per day earning capacity, the reduction of capacity due to cinders ranges in value from 50 cents to $40 or $50 per day. On a fuel consumption per locomotive of from 4 to 20 tons per day this loss in steaming or hauling efficiency is equivalent to from 10 cents to $4 per ton of coal fired, averaging about 50 cents. Putting it another way, each per cent. added to the slack means a reduction in earning capacity of the locomotive about 2 cents per ton of coal fired, beside an average loss of unburned fuel itself of another cent per ton per 1 per cent. of slack.

To restate: Each handling of the coal causes an addition to the slack of about 2 per cent., which results in fuel and efficiency losses of about 55 cents per ton. These losses are as low as 12 cents and as high as $4 per ton handled. These figures are given at considerable length to demonstrate the great desirability of designing coal-handling appliances, so that the coal will suffer the least possible crumbling.

The controlling factors in handling fuel on railways have been stated and developed, and may now be summarized:

Fuel for locomotive supply costs at the mine 75 cents to over $3 per ton, averaging but slightly over $1.

Freight charges over *other* ("foreign") lines range from nothing to about $3, and average slightly under $1 per ton.

Cost of transportation over company's own lines ranges from nothing to about $5 per ton, averaging roughly 40 cents.

Time on cars at mines and in transit is valued at from a minimum of about 3 cents per ton to over $5, averaging some 60 cents.

Empty car movement entails a further transportation cost of 35 cents a ton average, ranging up to $3.

Car detention at fueling station ranges from practically nothing to $10 per ton, averaging 60 cents.

Switching service at the fuel station costs from ½ cents to 5 cents per ton, the average being 2 cents.

Labor handling fuel at fueling stations ranges from 0.3 to 30 cents per ton, averaging 6 cents.

Power and supplies for fueling station, from nothing to 3 cents per ton, averaging about 2 cents.

Maintenance of fueling station, from 0.1 to 2 cents per ton, averaging a little over 1 cent.

Interest and depreciation on fueling station, from 0.4 to about 6 cents per ton, averaging about 3 cents.

Taxes, ground rent, supervision and other general charges, from 0.1 to about 0.3, average about 0.1.

Detention of locomotives being coaled, 0.1 cents per ton coaled, to $30, average about 9 cents.

Loss of fuel value and locomotive efficiency from crumbling due to handling, from 12 cents to $4, average over 50 cents.

SUMMARY OF LOCOMOTIVE FUEL COSTS PER TON.

Order of Importance.	Item.	Average Per Cent. of Cost.	Minimum, Cents.	Average, Dollars.	Maximum, Dollars.
2	Price at mine.....	24	75	$1.10	$3.00
3	Freight	19	0	.90	3.00
5	Transportation	9	0	.40	5.00
1	Use of transportation.	32	4	1.50	18.00
8	Switching	0	0	.02	.05
7	Total fuel station.....	2	1	.10	.35
6	Locomotive detention..	2	0	.09	30.00
4	Unnecessary slack....	12	12	.55	4.00
	Total	100%	92c.	$4.66	$63.40

By the above table it is seen that the most important consideration in railway fuel supply is the location of the source of the supply, with reference to the principal fueling stations where the supply is delivered to locomotives, and the efficient movement that is given to its transit.

The next consideration is price, relative to quantity (*i. e.*, per cent. of slack and sulphur). The last consideration is fuel station operating efficiency, including promptness of loading engines; Indeed this last factor may overshadow all others in money value, becoming ten times all other costs, including purchase price of fuel put together. Under circumstances where engine time is of great value (almost invariably the case where the engines are assigned to a "pool" or to "rounds"), the presence of a coaling station of the most modern type, coaling the engine with the greatest expedition and with the least injury of the fuel, becomes a transportation necessity.

The main features controlling design are:

1. Daily capacity required.
2. Is ground storage feasible or desired?
3. Terminal station or isolated plant.
4. Location.
5. Kind of car used.
6. Release of cars.
7. Switching.
8. Number of tracks served and clearances.
9. Kind of construction and fire risk and protection.
10. Installation or desirability of weighing or measuring apparatus.
11. Combination fueling operation with ashing, watering and sanding, in one station, and with one engine movement.

* See AMERICAN ENGINEER, April, 1906, page 124.

12. Kinds of fuel used, whether mixed, and preparation required.

13. Power available.

The variations in detail of design, the different combinations of elements of design, are so many and so varied, that no description or classification of the existing types will be attempted here. But the underlying elements of railway fueling stations may be outlined; such a station consists of:

A track or tracks (siding) for (a) reception of cars of coal; (b) holding of cars of coal; (c) unloading of cars of coal.

Cars with supply of coal; reservoir for coal storage (ground or bin); main and auxiliary; track or tracks for engine supply; intermediary to supply coal to engines from reservoir (or from cars). All fueling stations combine these elements in varying degree.

In conclusion it may be repeated that the several items, both direct and indirect, affecting locomotive fuel cost aggregate about $5 per ton, or about five times as much as the price of the fuel at the mine, although an attainable minimum of $1 per ton is indicated. The type and operation of the fueling station may affect this cost (indirectly rather than directly, as in saving locomotive time in coaling, or handling coal without crumbling) in very marked degree, and is worthy of the most serious study and attention. But little of definite value in the way of information upon which to base conclusions and make decisions can be secured without adequate records, complete as to detail, comprehensive as to interaction of all the various factors to be considered.

The installation of complete *records* of all the items of fuel cost here considered will yield far more instructive and valuable results in the reduction of railway fuel expense than an equal amount of money spent in any other way. The return is actually over 100 to 1.

OLD AGE PENSIONS.—In 1907 a Commission on Old Age Pensions was appointed in Massachusetts to study the various systems devised in other countries and in use among industrial and railroad corporations. Its report in a volume of 500 pages has lately been published. From a summary printed in the Boston *Transcript* the inference is drawn that its work has been thorough and valuable. The committee came out strongly against any scheme of non-contributing old age pensions, such as the one lately introduced in Great Britain. This it condemns on the score of expense, of discouragement of thrift, of a disintegrating effect upon the family, and of an unfavorable influence upon the rate of wages. Yet a plan of contributory retiring pensions for public employees, including those of towns and cities, is emphatically recommended by the committee, and the scheme of retiring allowances for aged workmen is urged upon large employers of labor, the whole to be based squarely upon the contributory principle. In line with this vigorous and wholesome assertion of the duty of self-reliance, is the recommendation that "thrift should be included among the subjects of compulsory instruction in the public schools."

THE HEALTHIEST TRADE.—Compilations have been made, from Government reports, showing the relative liability to disease of the employees in various trades. According to the returns so far tabulated by the Census Bureau, the occupation of the steam railroad employee is the healthiest of all. In a long list of maladies, the only one to which the railroad employee is more liable than workers in manufacturing or agricultural trades is typhoid fever, and to this he is far less liable than are the workers classed as "laborers." The figures show that the railroad man is far less liable to consumption than the workers in the manufacturing and mechanical industries. He is less apt to commit suicide than any other wage earner, and suffers less from rheumatism and malarial fever. His nervous system, according to the statistics, is in excellent shape. Heart disease and pneumonia are rarer among railroad employees.

SAFE SPEEDS FOR CAST IRON FLYWHEELS.*

The speed at which a flywheel may be safely run depends upon the material of which it is constructed, upon its design, and upon the conditions under which it is used.

The relative fitness of various materials for flywheel rims is measured by dividing the tensile strength T per unit of area, by the weight W per unit of volume. The higher the value of T/W, the better is the material fitted for use in a flywheel rim. The strength of the rim of a flywheel to resist centrifugal force cannot be doubled by doubling the quantity of material in the rim, because the centrifugal force is doubled also when the quantity of material is doubled. It results then, that for any given material, the strength to resist centrifugal force does not depend upon the quantity of material in the rim, but only upon the tensile strength of that material, and for any given material in a flywheel rim there is a definite rim speed or velocity that cannot be safely exceeded.

The formula for determining the safe rim speed of flywheels is as follows:

$$V = 97.8\sqrt{\frac{T}{W} \times \frac{E}{F}}$$

in which

V = Safe rim speed in feet per minute,
T = Ultimate tensile strength of material in flywheel rim in pounds per square inch,
W = Weight of material in flywheel rim in pounds per cubic inch,
E = Efficiency of joints in flywheel rim,
F = Factor of safety.

In the case of cast iron, an ultimate tensile strength of 10,000 pounds per square inch is as much, probably, as can be assumed with safety. If then a factor of safety of 10 be taken in a wheel with a solid rim, the formula becomes (E being equal to 1 since there are no joints):

$$V = 97.8\sqrt{\frac{10{,}000}{0.26} \times \frac{1}{10}}$$

or 6,060 feet per minute. That is to say, the safe rim speed for a cast-iron wheel made in one piece does not much exceed a mile a minute. More accurately, a cast-iron wheel, made in one piece and well proportioned, reaches the limit of safety at a rim speed of 1.15 mile per minute.

But if there are joints in the rim of a flywheel, the factor of safety becomes considerably less than 10. Thus, if the efficiency of the joint is only 50 per cent. of the solid metal, the factor of safety in a cast-iron wheel run at a rim speed of 6,060 feet per minute is only 5, and if the efficiency of the joint is only 25 per cent. of the solid metal, the factor of safety is only 2½.

The subject of rim joints is worthy of much more study and experiment than has been given to it. It is to be borne in mind that

$$V = 3.14 \times D \times N$$

in which.

V = Rim speed in feet per minute,
D = Diameter of wheel in feet,
N = Number of revolutions per minute.

The stress, due to centrifugal force, in the rim of a flywheel made of any material whatever, and also the bursting speed, may be obtained from the following formulas:

$$P = \frac{W \times V^2}{2.66} \qquad B = 1.63\sqrt{\frac{T \times E}{W}}$$

in which

P = Stress in pounds per square inch,
V = Rim speed in feet per second,
B = Rim speed in feet per second at which disruption will occur,
T = Tensile strength of the material in pounds per square inch,
W = Weight in pounds per cubic inch,
E = Efficiency of the rim joint.

By placing the maintenance of belting in the hands of a specialist, with instructions to prevent failures, not remedy them, and to use only the best quality of material for repairs and renewals, the belting expense in a large railroad shop decreased from $1,000 to $300 per month and the number of failures from 300 to 55 in about 15 months. The conditions before this was done were not worse than in many other railroad shops.

* From the Fidelity and Casualty Company's book on "The Prevention of Industrial Accidents."